TM 11-2224

DEPARTMENT OF THE ARMY TECHNICAL MANUAL

See C1,2

TELETYPEWRITER TEST SET TS-611A/FG

DEPARTMENT OF THE ARMY • JANUARY 1956

WARNING

DANGEROUS VOLTAGES EXIST IN THIS EQUIPMENT

Be careful when working on or near transformer T302 or tube V304 on the RECT PEAK VM panel; potentials as high as 300 volts are present in the circuits associated with these parts. Potentials of similar magnitude are also present in the circuits of the PWR SUP panel and the REG TUBE RECT panels. Be careful when working on the 115-volt ac line connections. Always turn the power off before repairing the equipment or replacing parts.

DON'T TAKE CHANCES!

TECHNICAL MANUAL
TELETYPEWRITER TEST SETS TS-611A/FG AND TS-611C/FG

TM 11-2224
CHANGES No. 2

HEADQUARTERS,
DEPARTMENT OF THE ARMY
WASHINGTON, D.C., *13 September 1963*

TM 11-2224, 26 January 1956, is changed as follows:

Page 2. Paragraph 1. Delete subparagraph *b.*

Add paragraph 1.1 after paragraph 1.

1.1. Index of Publications

Refer to the latest issue of DA Pam 310-4 to determine whether there are new editions, changes, or additional publications pertaining to this equipment. DA Pam 310-4 is a current index of technical manuals, technical bulletins, supply bulletins, lubrication orders, and modification work orders which are available through publications supply channels. The index lists the individual parts (-10, -20, -35P, etc) and the latest changes to and revisions of each equipment publication.

Delete paragraph 2 and substitute:

2. Forms and Records

a. Reports of Maintenance and Unsatisfactory Equipment. Use equipment forms and records in accordance with instructions in TM 38-750.

b. Report of Damaged or Improper Shipment. Fill out and forward DD Form 6 (Report of Damaged or Improper Shipment) as prescribed in AR 700-58 (Army), NAVSANDA Publication 378 (Navy), and AFR 71-4 (Air Force).

c. Reporting of Equipment Manual Improvements. The direct reporting by the individual user of errors, omissions, and recommendations for improving this manual is authorized and encouraged. DA Form 2028 (Recommended changes to DA technical manual parts lists or supply manual 7, 8, or 9) will be used for reporting these improvements. This form will be completed in triplicate using pencil, pen, or typewriter. The original and one copy will be forwarded direct to: Commanding Officer, U.S. Army Electronics Materiel Support Agency, ATTN: SELMS-MP, Fort Monmouth, New Jersey. One information copy will be furnished to the individual's immediate supervisor (e.g., officer, noncommissioned officer, supervisor, etc).

Page 37. Chapter 4, heading. Change the heading to: MAINTENANCE INSTRUCTIONS.

Delete sections I and II and substitute:

Section I. OPERATOR'S (FIRST ECHELON) MAINTENANCE

42. Scope of Operator's Maintenance

The maintenance duties assigned to the operator of the teletypewriter test set are listed below with a reference to the paragraphs covering the specific maintenance functions. The duties assigned do not require any special tools or test equipment. Cleaning Compound (FSN 7930-

* This change supersedes TM 11-6625-281-10P, 17 July 1959, and so much of TM 11-6625-281-20P, 17 July 1959, as pertains to maintenance allocation for Teletypewriter Test Set TS-611A/FG.

395–9542) and a lint-free cloth are required for these services.

a. Daily preventive maintenance checks and services (par. 45).

b. Weekly preventive maintenance checks and services (par. 46).

c. Cleaning (par. 47).

43. Operator's Preventive Maintenance

Preventive maintenance is the systematic care, servicing, and inspection of equipment to prevent the occurrence of trouble, to reduce downtime, and to assure that the equipment is serviceable.

a. *Systematic Care.* The procedures given in paragraphs 44 through 47 cover routine systematic care and cleaning essential to proper upkeep and operation of the equipment.

b. *Preventive Maintenance Checks and Services.* The preventive maintenance checks and services chart (pars. 45 and 46) outlines functions to be performed at specific intervals. These checks and services are to maintain Army electronic equipment in a combat serviceable condition; that is, in good general (physical) condition and in good operating condition. To assist operators in maintaining combat serviceability, the chart indicates what to check, how to check, and what the normal conditions are. The *references* column lists the illustrations, paragraphs, or manuals that contain supplementary information. If the defect cannot be remedied by the operator, higher echelon maintenance or repair is required. Records and reports of these checks and services must be made in accordance with the requirements set forth in TM 38–750.

44. Preventive Maintenance Checks and Services Periods

Operator's preventive maintenance checks and services of the teletypewriter test set are required on a daily and weekly basis.

a. Paragraph 45 specifies the checks and services that must be accomplished daily and under the special conditions listed below:

(1) When the equipment is reinstalled after removal for any reason.

(2) At least once each week if the equipment is maintained in a standby condition.

b. Paragraph 46 specifies the checks and services that must be accomplished once each week. These checks and services are made *concurrently with* those made daily.

45. Daily Preventive Maintenance Checks and Services Chart

Sequence No.	Item	Procedure	References
1	Teletypewriter test set	Check for completeness, including extension units and spare parts.	Par. 7 and TM 11–6625–281–10P.
2	Front panel components	While making the check in item 3 below, observe the following: *a*. See that the electron tubes, lamps, and plug-in relays are firmly seated. *b*. Tighten all panel mountings and covers.	Par. 52*b* and *c*.
3	Exterior surfaces	See that all cabinet and front panel surfaces covers, and meters on the teletypewriter test set and extension units are free from dust, oil, grease, moisture, and broken glass.	Par. 47.
4	Controls, switches and meter pointers.	While making the operating check given in item 5 below, observe the following: *a*. Controls and switches should show no evidence of binding, scraping, excessive looseness, or improper setting for the electrical option involved. *b*. Meter pointer movements in the meters on the meter panel and the extension units should be smooth and not stick.	

45. Daily Preventive Maintenance Checks and Services Chart—(Continued)

Sequence No.	Item	Procedure	References
5	Operation	Operate the equipment in accordance with paragraph 55.	

46. Weekly Preventive Maintenance Checks and Services Chart

Sequence No.	Item	Procedure	References
1	Fuses	Check the seating and condition of the fuses.	Pars. 16a and 52*a*.
2	Polar relays	Inspect the polar relays for broken or frayed wiring, bent pins or springs, and loose screws.	Par. 52*c*.
3	Front panel components......	Check all front-panel-mounted components for bulges, leaks, or other signs of overheating and damage.	
4	Cords and cables	Inspect the connecting cords and cables for cuts, cracks, strain, fraying, or other deterioration.	

47. Cleaning

Inspect the exterior of the teletypewriter test set. The exterior surfaces should be clean and free from dust, dirt, grease, oil, mildew, and fungus.

a. Remove dust, loose dirt, and moisture with a soft clean cloth or brush.

Warning: **Cleaning compound is flammable and its fumes are toxic. *Do not* use near a flame; provide adequate ventilation.**

b. Remove oil, grease, fungus, mildew, and ground-in dirt from the cabinet and panels; use a cloth dampened (not wet) with Cleaning Compound (FSN 7930–395–9542). After cleaning, wipe dry with a cloth.

c. Remove dust or dirt from the jacks with a brush.

Warning: **Compressed air is dangerous and can cause serious damage to the eyes, ears, nose, and other parts of the body. Be careful to direct compressed air away from the body. Compressed air can cause mechanical damage to the equipment. *Do not* use compressed air which exceeds the permissible pressure. Do not use compressed air to dry parts where cleaning compound has been applied.**

d. If available, dry compressed air may be used at a line pressure not exceeding 60 pounds per square inch to remove dust from inaccessible places.

Caution: **Do not press on the meter faces (glass) when cleaning; the meter may become damaged.**

e. Clean the front panel meters and control knobs; use a soft clean cloth. If dirt is difficult to remove, dampen the cloth with water; use mild soap if necessary.

Section II. ORGANIZATIONAL (SECOND ECHELON) MAINTENANCE

48. Scope of Second Echelon Maintenance

Second echelon maintenance of the teletypewriter test set includes the maintenance performed by the operator (para 42) and those listed below.

a. Preventive maintenance (pars. 49–49.2).

b. Troubleshooting (pars. 50–55).

49. Second Echelon Preventive Maintenance

a. Preventive maintenance is the systematic care, inspection, and servicing of equipment to maintain it in serviceable condition, prevent breakdowns, and assure maximum operational capability. Preventive maintenance is the responsibility of all echelons concerned with the

equipment and includes inspection, testing, and repair or replacement of parts (when authorized) that inspection and tests indicate would probably fail before the next scheduled periodic service. Preventive maintenance checks and services of the teletypewriter test set at the second echelon level are made at monthly intervals (par. 49.1) unless otherwise directed by the commanding officer. The preventive maintenance checks and services for longer intervals should be scheduled concurrently with those for shorter intervals.

b. Maintenance forms and records to be used and maintained on this equipment are specified in TM 38–750. Paragraph 2 contains additional information concerning submission of specific forms.

c. The preventive maintenance checks and services chart (par. 49.2) outlines functions to be performed at monthly intervals. To assist organizational personnel in maintaining combat serviceability, the chart indicates what to check, how to check, and what the normal conditions are; the *references* column lists the illustrations, paragraphs, or manuals that contain pertinent information. If the defect cannot be remedied at the organizational level, deadline the equipment in accordance with TM 38–750 and refer the equipment to higher echelon.

d. Remove from metal surfaces rust or corrosion found during preventive maintenance inspections, by lightly sanding the surfaces with fine sandpaper. Brush two thin coats of paint on the bare metal to protect it from further corrosion. Refer to the applicable cleaning and refinishing practices specified in TM 9–213.

49.1. Monthly Maintenance

Perform the maintenance functions indicated in the monthly preventive maintenance checks and services chart (par. 49.2) once each month. A month is defined as approximately 30 calendar days of 8-hour-per-day operation. If the equipment is operated 16 hours a day, the monthly maintenance should be performed at 15-day intervals. Adjustment of the maintenance interval must be made to compensate for any unusual operating conditions. Equipment maintained in a standby (ready for immediate operation) condition must have monthly maintenance performed on it. Equipment in limited storage does not require monthly maintenance, but requires service before operation.

49.2. Monthly Preventive Maintenance Checks and Services Chart

Sequence No.	Item	Procedure	References
1	Exterior surfaces	Inspect the cabinet exterior for loose screws and rust or corrosion. Tighten all screws when necessary; remove rust or corrosion.	Par. 49*d*.
2	Interior components	Remove dirt and moisture from the components at the rear of the teletypewriter test set. *a*. Clean and tighten connections, mountings and terminal boards. *b*. Inspect all internal components for cracks, blistering, leaks, or other signs of overheating and damage.	Par. 47.
3	Radiation shield	Inspect the radiation shield for looseness; tighten if necessary.	

Page 40. Delete section III.

Page 130. Add appendixes, I, II, and III, after chapter 7.

APPENDIX I
REFERENCES

Following is a list of applicable references available to the operator and organizational maintenance personnel of the teletypewriter test set.

AR 700–58	Report of Damaged or Improper Shipment.
AR 750–5	Organization, Policies, and Responsibilities for Maintenance Operations.
DA Pam 310–4	Index of Technical Manuals, Technical Bulletins, Supply Bulletins, Lubrication Orders, and Modification Work Orders.
TM 9–213	Painting Instructions for Field Use.
TM 38–750	The Army Equipment Record System and Procedures.

APPENDIX II
MAINTENANCE ALLOCATION
Section I. INTRODUCTION

1. General

a. This section assigns maintenance functions to be performed on components, assemblies, and sub-assemblies by the lowest appropriate maintenance echelon.

b. Columns in the maintenance allocation chart are as follows:

(1) *Component*. This column shows only the nomenclature or standard item name. Additional descriptive data is included only where clarification is necessary to identify the component. Components, assemblies, and subassemblies are listed in top-down order. That is, the assemblies which are part of a component are listed immediately below that component, and the sub-assemblies which are part of an assembly are listed immediately below that assembly. Each generation breakdown (components, assemblies, or sub-assemblies) are listed in disassembly order or alphabetical order.

(2) *Maintenance function*. This column indicates the various maintenance functions allocated to the echelons.

(*a*) *Service*. To clean, to preserve, and to replenish lubricants.

(*b*) *Adjust*. To regulate periodically to prevent malfunction.

(*c*) *Inspect*. To verify serviceability and to detect incipient electrical or mechanical failure by scrutiny.

(*d*) *Test*. To verify serviceability and to detect incipient electrical or mechanical failure by use of special equipment such as gages, meters, etc.

(*e*) *Replace*. To substitute serviceable components, assemblies, or subassemblies, for unserviceable components, assemblies, or subassemblies.

(*f*) *Repair*. To restore an item to serviceable condition through correction of a specific failure or unserviceable condition. This function includes but is not limited to welding, grinding, riveting, straightening, and replacement of parts other than the trial and error replacement of running spare type items such as fuses, lamps, or electron tubes.

(*g*) *Align*. To adjust two or more components of an electrical system so that their functions are properly synchronized.

(*h*) *Calibrate*. To determine, check, or

rectify the graduation of an instrument, weapon, or weapons system, or components of a weapons system.

(*i*) *Overhaul*. To restore an item to *completely serviceable* condition as prescribed by serviceability standards. This is accomplished through employment of the technique of "Inspect and Repair Only as Necessary" (IROAN). Maximum utilization of diagnostic and test equipment is combined with minimum disassembly of the item during the overhaul process.

(*j*) *Rebuild*. To restore an item to a standard as near as possible to original or new condition in appearance, performance, and life expectancy. This is accomplished through the maintenance technique of complete disassembly of the item, inspection of all parts or components, repair or replacement of worn or unserviceable elements using original manufacturing tolerances and/or specifications and subsequent reassembly of the item.

(3) *1st, 2d, 3d, 4th, 5th echelons*. The symbol X placed in Columns 3 through 7 indicates the echelon responsible for performing that particular maintenance operation, but does not necessarily indicate that repair parts will be stocked at that level. Echelons higher than the echelon marked by X are authorized to perform the indicated operation.

(4) *Tools required*. This column indicates codes assigned to each individual tool equipment, test equipment, and maintenance equipment referenced. The grouping of codes in this column of the maintenance allocation chart indicates the tool, test, and maintenance equipment required to perform the maintenance function.

(5) *Remarks*. Entries in this column will be utilized when necessary to clarify any of the data cited in the preceding column.

c. Columns in the allocation of tools for maintenance functions are as follows:

(1) *Tools required for maintenance functions*. This column lists tools, test, and maintenance equipment required to perform the maintenance functions.

(2) *1st, 2d, 3d, 4th, 5th echelon*. The dagger (†) symbol in these columns indicates the echelons normally allocated the facility.

(3) *Tool code*. This column lists the tool code assigned.

2. Maintenance by Using Organizations

When this equipment is used by signal services organizations organic to theater headquarters or communication zones to provide theater communications, those maintenance functions allocated up to and including fourth echelon are authorized to the organization operating this equipment.

SECTION II. MAINTENANCE ALLOCATION CHART

PART OR COMPONENT	MAINTENANCE FUNCTION	ECHELON 1	2	3	4	5	TOOLS REQUIRED	REMARKS
TEST SETS, TELETYPEWRITER TS-611A/FG AND TS-611C/FG	service	X						
	adjust				X		1,3,4,7,8,9, 10	
	inspect			X				
	test				X		1,2,3,4,6,7, 8,9	
						X	5	TV-2/U required.
	repair				X		10	
	align				X		1,3,4,7,8,9, 10	
	overhaul					X	1 thru 10	

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SECTION III. ALLOCATION OF TOOLS FOR MAINTENANCE FUNCTIONS

PART OR COMPONENT	ECHELON 1	2	3	4	5	TOOL CODE	REMARKS
TS-611A/FG & TS-611C/FG (continued)							
DISTORTION TEST SET TS-383/GG				†	†	1	
MULTIMETER, METER ME-26/U				†	†	2	
MULTIMETER TS-352/U				†	†	3	
OSCILLOSCOPE OS-8/U				†	†	4	
TEST SET, ELECTRON TUBE TV-2/U					†	5	
TEST SET, ELECTRON TUBE TV-7/U				†		6	
TEST SET I-181-B				†	†	7	
TEST SET I-193-C				†	†	8	
TEST SET TS-190/U				†	†	9	
TOOL EQUIPMENT TE-50B				†	†	10	

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APPENDIX III

BASIC ISSUE ITEMS LIST, TEST SETS, TELETYPEWRITER

TS–611A/FG AND TS–611C/FG

Section I. INTRODUCTION

1. Scope

a. This appendix lists items supplied for initial operation and for running spares. The list includes tools, parts, and material issued as part of the major end item. The list includes all items authorized for basic operator maintenance of the equipment. End items of equipment are issued on the basis of allowances prescribed in equipment authorization tables and other documents that are a basis for requisitioning.

b. Columns are as follows:

(1) *Federal stock number.* This column lists the 11-digit Federal stock number.

(2) *Designation by model.* The dagger (†) indicates model in which the part is used and further, by its position, designates the item number in which the item is identified.

(3) *Description.* Nomenclature or the standard item name and brief identifying data for each item are listed in this column. When requisitioning, enter the nomenclature and description.

(4) *Unit of issue.* The unit of issue is each unless otherwise indicated and is the supply term by which the individual item is counted for procurement, storage, requisitioning, allowances, and issue purposes.

(5) *Expendability.* Nonexpendable items are indicated by NX. Expendable items are not annotated.

(6) *Quantity authorized.* Under "Items Comprising an Operable Equipment", the column lists the quantity of items supplied for the initial operation of the equipment. Under "Running Spare Items" the quantities listed are those issued initially with the equipment as spare parts. The quantities are authorized to be kept on hand by the operator for maintenance of the equipment.

(7) *Illustration.* The "Item No." column lists the reference symbols used for identification of the items in the illustration or text of the manual.

FEDERAL STOCK NUMBER	DESIGNATION BY MODEL						DESCRIPTION	UNIT OF ISSUE	EXP	QTY AUTH	ILLUSTRATION FIGURE NO.	ILLUSTRATION ITEM NO.
6625-568-4912							TEST SETS, TELETYPEWRITER TS-611A/FG AND TS-611C/FG: Type of tests: measurement of Teletypewriter signal distortion; operating data, detects displacement of transitions, indicates average distortion on 'BIAS' meter, indicates largest distortion on total distortion meter.					
							ITEMS COMPRISING AN OPERABLE EQUIPMENT					
							NOTE: Model Column 1 refers to TS-611A/FG; Model Column 2 refers to TS-611C/FG.					
Ord thru AGC	†	†					TECHNICAL MANUAL TM 11-2224			2		
	†	†					TEST SETS, TELETYPEWRITER TS-611A/FG AND TS-611C/FG: (BASIC COMPONENT)		NX	1		
6625-219-9920	†	†					TEST SET SUB-ASSEMBLY: used as a remote testing position for Test Set, Teletypewriter; Masketh Telephone and Radio Corp. p/n D-89SO; Weco Spec KS-7525		NX	5		
							RUNNING SPARE ITEMS					
							TEST SETS, TELETYPEWRITER TS-611A/FG AND TS-611C/FG					
							COMPARISON PANEL					
5945-188-5631	†						RELAY ARMATURE: Weco type No. 255A			1		KZ thru K5
		†								1		
5945-523-1759	†						RELAY, ARMATURE: Weco type No. 275C			1		K1
		†								1		
							DISTRIBUTION PANEL					
5960-188-8555	†						ELECTRON TUBE: MIL type 6F8G			1		V203
5960-188-8536	†						ELECTRON TUBE: MIL type 6H6Q			1		V201
5960-114-3808	†						ELECTRON TUBE: MIL type 6Y6G			1		V202
5960-188-8588	†						ELECTRON TUBE: MIL type 338A			1		V204,205
		†								1		EE,EF

FEDERAL STOCK NUMBER	DESIGNATION BY MODEL					DESCRIPTION	UNIT OF ISSUE	EXP	QTY AUTH	ILLUSTRATION	
										FIGURE NO.	ITEM NO.
						TS-611A/FG & TS-611C/FG (continued)					
5960-082-3185		†				ELECTRON TUBE: MIL type 396A			1		ED
5920-199-9498	†	†				FUSE, CARTRIDGE: 1/2 amp; 250v max; mdl 1/2 MIL type No. F02GR500B			10		
5920-131-9817		†				FUSE, CARTRIDGE: Bussman mdl 1-1/4			5		CJ,CJ
						TEST SET SUB-ASSEMBLY					
6240-508-0315		†				LAMP, INCANDESCENT: Weco type No. E1			2		
6240-238-8528	†					LAMP, INCANDESCENT: Weco type No. K1			2		E1
		†							2		
						JACK STRIP					
6240-238-8528	†	†				LAMP, INCANDESCENT: Weco type No. K1			1		
						POWER AND CURRENT SUPPLY PANEL					
5960-188-0968	†					ELECTRON TUBE: MIL type OC3W			1		V101,102
		†							1		EA, EC
5960-193-5085	†					ELECTRON TUBE: MIL type OD3W			1		V104
		†							1		ED
5960-188-3944	†					ELECTRON TUBE: MIL type 2A5			1		V105
5960-188-8606	†					ELECTRON TUBE: MIL type 5T4			1		V102
5960-114-3808	†					ELECTRON TUBE: MIL type 6Y6G			1		V106
5960-617-9172		†				ELECTRON TUBE: MIL type 349A			1		EE
5960-166-7681		†				ELECTRON TUBE: MIL type 350B			1		
5920-199-3968	†	†				FUSE, CARTRIDGE: 0.800 amp; 250v max; mdl 8/10			5		
						24V DC POWER SUPPLY					
5920-356-2185		†				FUSE, CARTRIDGE: Bussman mdl 1/10			10		CA,CB,CC

FEDERAL STOCK NUMBER	DESIGNATION BY MODEL		DESCRIPTION	UNIT OF ISSUE	EXP	QTY AUTH	ILLUSTRATION FIGURE NO.	ILLUSTRATION ITEM NO.
			TS-611A/FG AND TS-611C/FG (continued)					
			130V DC POWER SUPPLY					
5960-116-9961	†		ELECTRON TUBE: MIL type 394A			1		V1,V2
		†				1		
5920-010-6652	†		FUSE, CARTRIDGE: 3 amp; 250v max MIL type F02GR300A			5		AC1,AC2
5920-356-2185		†	FUSE, CARTRIDGE: Bussman mdl 1/10			10		CD,CE,CF CG,CH
5920-142-7363		†	FUSE, CARTRIDGE: Bussman mdl 3.2			10		DAC1, DAC2
5945-257-8014		†	RELAY, THERMAL: Thomas A. Edison Ind. p/n B1789M58-501			1		EK2
			RECTIFIER PEAK VOLTMETER					
5960-501-1947		†	ELECTRON TUBE: MIL type 5U4GB			1		EB
5960-100-7309	†		ELECTRON TUBE: MIL type 56			2		V301, V302,
						-		V303
5960-100-7320	†		ELECTRON TUBE: MIL type 80			1		V304
5960-188-8542		†	ELECTRON TUBE: MIL type 274A			1		ED
5960-082-3185		†	ELECTRON TUBE: MIL type 396A			1		EC
5920-199-9498	†	†	FUSE, CARTRIDGE: 1/2 amp; 250v max; mdl 1/2; MIL type No. F02GR500B			5		

By Order of the Secretary of the Army:

EARLE G. WHEELER,
General, United States Army,
Chief of Staff.

Official:

J. C. LAMBERT,
Major General, United States Army,
The Adjutant General.

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Svc Colleges (2)
Br Svc Sch (2)
Army Dep (2)
Sig Dep (OS) (2)
Sig Sec, GENDEP (5)
USA Trans Tml Comd (1)
USAOSA (1)
Sig Fld Maint Shops (3)
USA Elct Spt Agcy (15)
USASCC, Det #2 (2)
USASCC, Det #4 (2)
USASCC, Det #5 (2)
USASCC, Det #6 (2)
USASCC, Det #7 (2)
USASCC, Det #8 (2)
Units org under fol TOE (2 cy ea UNOINDC):
11–7
11–16
11–57
11–500 (Tms AA–AC) (4)
11–587
11–592
11–597

NG: None.

USAR: None.

For explanation of abbreviations used, see AR 320–50.

TECHNICAL MANUAL

TELETYPEWRITER TEST SETS TS-611A/FG AND TS-611C/FG

TM 11-2224
CHANGES No. 1

HEADQUARTERS,
DEPARTMENT OF THE ARMY
WASHINGTON 25, D.C., *9 January 1963*

TM 11-2224, 26 January 1956, is changed as indicated so that the manual also applies to:

Nomenclature	*Order No.*	*Serial No.*
Teletypewriter Test Set TS-611C/FG	15808-PP-62	1 through 5

Change the title of the manual to TELETYPEWRITER TEST SETS TS-611A/FG AND TS-611C/FG.

Page 2, chapter 1. Add the following note below the title of chapter 1:

Note. Teletypewriter Test Set TS-611C/FG is similar to Teletypewriter Test Set TS-611A/FG. Information in this manual applies to both sets unless otherwise specified.

Add (TS-611A/FG only) at the end of the caption for the following figures:

Page 14, figure 6.
Page 24, figure 15.
Page 25, figure 16.
Page 35, figure 18.
Page 58, figure 25 (foldout).
Page 60, figure 26 (foldout).
Page 66, figure 28 (foldout).
Page 68, figure 29 (foldout).
Page 69, figure 30.
Page 76, figure 33 (foldout).
Page 80, figure 35.
Page 85, figure 38.
Page 106, figure 43 (foldout).
Page 108, figure 44.
Page 112, figure 48.
Page 113, figure 49.
Page 114, figure 50.
Page 115, figure 52.
Page 116, figure 53.
Page 124, figure 59 (foldout).
Figure 61 (foldout).
Figure 62 (foldout).
Page 125, figure 60.
Page 126, figure 63.
Figure 64 (foldout).
Page 127, figure 65.
Page 128, figure 67 (foldout).
Page 129, figure 68.
Page 130, figure 69 (foldout).
Figure 71 (foldout).
Figure 73 (foldout).

Page 3, figure 1. Add to figure 1:

NOTE:

IN THE TS-611C/U ONLY, THE UPPER SPARE PANEL IS REPLACED BY THE 75 SPEED PANEL.

Page 8, paragraph 8. Make the following changes:

Subparagraph *f*. Change the heading to: *DISTRIBUTOR Panels* (*TS-611A/FG only*).

Add subparagraph *f.1.*

f.1. DISTRIBUTOR and 75 SPEED Panels (*TS-611C/U only*). (Added.) The DISTRIBUTOR panels of the TS-611C/FG and TS-611A/FG are similar except that on the TS-611C/FG, the potentiometers and switches on the *left* side of the upper portion are used to set up the teletypewriter test set for 100-wpm operation only; those on the *right* side, for 60 or 66 wpm. An additional group of switches and potentiometers, for setting up for 75-wpm operation, are on the 75 SPEED panel (fig. 14.1), mounted directly below the DISTRIBUTOR panel. These switches and potentiometers are appropriately labeled with their function and speed (COARSE, FINE, DECR, and ORIENT). The SPEED switch, at the top of the TS-611A/FG DISTRIBUTOR panels, does not appear on the TS-611C/FG; a 3-position switch labeled 60-75-100 located on the jack and switch panel provides speed selection for this model.

Paragraph 10.

10. Running Spares
(Superseded)

The chart below contains a list of the running spares that are supplied with Teletypewriter Test Sets TS-611A/FG and TS-611C/FG. The

spare parts are contained in a separate carton in the shipping crate.

Quantity		Item
TS-611A/FG	TS-611C/FG	
1	--------	Electron tube, type 2A5.
	1	Electron tube, type 349A.
1	--------	Electron tube, type 6F8G.
	1	Electron tube, type 396A.
1	--------	Electron tube, type 6H6.
1	--------	Electron tube, type 6Y6G.
	1	Electron tube, type 350B.
1	--------	Electron tube, type 80.
	1	Electron tube, type 274A.
1	1	Electron tube, type OD3/VR-150.
1	1	Electron tube, type 338A.
1	1	Electron tube, type OC3/VR-105.
1	--------	Electron tube, type 5T4.
	1	Electron tube, type 5U4G.
2	--------	Electron tube, type 56.
2	1	Electron tube, type 394A.
1	1	Polar relay, type 255A.
1	1	Mercury relay, type 275C.
1	1	Thermal relay.
	5	MDL 8/10 cartridge fuse (Bussman).
	10	MDL 1/2 Fusetron (Bussman).
	10	MDL 1/10 Fusetron (Bussman).
	5	MDL 1¼ Fusetron (Bussman).
	10	Littlefuse #312003, 3A, 250V.
	3	Lamp (BSY), WECO K1.

Page 9, paragraph 11. Add paragraph 11.1.

11.1. Difference in Models

(Added)

Teletypewriter Test Set TS-611C/FG differs from Teletypewriter Test Set TS-611A/FG as follows:

a. Teletypewriter Test Set TS-611C/FG incorporates additional circuitry and associated adjustments in the DISTRIBUTOR panel, and some minor wiring changes in the input circuit. These changes permit presetting the TS-611C/FG for testing teletypewriter circuits operating at any one of three speeds (60, 75, and 100 wpm). This condition eliminates the need for readjustment of the 75- or 100-wpm circuits as required in the TS-611A/FG (par. 30 through 33). As a result, the TS-611C/FG is more flexible and convenient to use, especially at the extension units.

b. Some tube types have been changed to later preferred types (par. 16*b*).

c. Some electron tube diodes have been replaced with solid state diodes with a consequent reduction in power requirement and heat generation (par. 16*b*).

d. A comparison chart for the reference designators for the components of the TS-611A/FG and TS-611C/FG is given in paragraph 56.1. Refer to the appropriate schematic and wiring diagrams when using the TS-611A/FG or TS-611C/FG (par. 115).

Page 11, paragraph 16*a*, chart (Superseded).

Reference symbol		Size (amp)		Panel	Location on panel
TS-611A/FG	TS-611C/FG	TS-611A/FG	TS-611C/FG		
AC1	AC1	3	3	REG TUBE RECT +TG	Fuse holder under front cover.
AC2	AC2	3	3	REG TUBE RECT +TG	Fuse holder under front cover.
AC1	AC1	3	3	REG TUBE RECT −TG	Fuse holder under front cover.
AC2	AC2	3	3	REG TUBE RECT −TG	Fuse holder under front cover.
		0. 8	0. 8	PWR SUP	In ac plug on rear of panel (two fuses required).
		0. 5	0. 5	DISTRIBUTOR	In ac plug on rear of panel (two fuses required).
		0. 5	0. 5	RECT PEAK VM	In ac plug on rear of panel (two fuses required).
F601	----------	2	--------	24 VOLT SUP	24V fuse holder on front of panel.
	J	--------	1. 25	24 VOLT SUP	J-fuse holder on front of panel.
F602	----------	1	--------	24 VOLT SUP	−130V fuse holder on front of panel.
F603	----------	1	--------	24 VOLT SUP	+130V fuse holder on front of panel.
	A	--------	0. 1	24 VOLT SUP	A-fuse holder on front of panel.
	B	--------	0. 1	24 VOLT SUP	B-fuse holder on front of panel.
	C	--------	0. 1	24 VOLT SUP	C-fuse holder on front of panel.
	D	--------	0. 1	24 VOLT SUP	D-fuse holder on front of panel.
	E	--------	0. 1	24 VOLT SUP	E-fuse holder on front of panel.
	F	--------	0. 1	24 VOLT SUP	F-fuse holder on front of panel.
	G	--------	0. 1	24 VOLT SUP	G-fuse holder on front of panel.
	H	--------	0. 1	24 VOLT SUP	H-fuse holder on front of panel.

Page 12, paragraph 16*b*, chart (Superseded).

Reference symbol		Type		Panel	Location on panel
TS–611A/FG	TS–611C/FG	TS–610A/FG	TS–611C/FG		
V101	A	OC3/VR–105.	OC3	PWR SUP	Front of panel (fig. 13).
V102	B	5T4	5U4G	PWR SUP	Front of panel (fig. 13).
V103	C	OC3/VR–105.	OC3	PWR SUP	Front of panel (fig. 13).
V104	D	OD3/VR–150.	OD3	PWR SUP	Front of panel (fig. 13).
V105	E	2A5	349A	PWR SUP	Front of panel (fig. 13).
V106	F	6Y6G	350B	PWR SUP	Front of panel (fig. 13).
V201	Not used	6H6	Not used	DISTRIBUTOR	Front of panel (fig. 14).
V202	B	6Y6G	350B	DISTRIBUTOR	Front of panel (fig. 14).
V203	D	6F8G	396A	DISTRIBUTOR	Front of panel (fig. 14).
V204	E	338A	338A	DISTRIBUTOR	Front of panel (fig. 14).
V205	F	338A	338A	DISTRIBUTOR	Front of panel (fig. 14).
V301	(Note 1)	56	(Note 1)	RECT PEAK VM	Rear of panel (fig. 48).
V302	(Note 1)	56	(Note 1)	RECT PEAK VM	Rear of panel (fig. 48).
V303	C	56	396A	RECT PEAK VM	Rear of panel (fig. 48 and 48.1).
V304	D	80	274A	RECT PEAK VM	Rear of panel (fig. 48 and 48.1).
V1		394A	394A	REG TUBE RECT +TG	Under front cover (fig. 1) (note 2).
V2		394A	394A	REG TUBE RECT +TG	Under front cover (fig. 1) (note 2).
V1		394A	394A	REG TUBE RECT −TG	Under front cover (fig. 1) (note 2).
V2		394A	394A	REG TUBE RECT −TG	Under front cover (fig. 1) (note 2).

Notes:

1. Replaced by crystal diodes VR11 and VR12 in the TS–611C/FG (fig. 48.1).
2. Place cap on top of tube.

Page 13, paragraph 18. Make the following changes:

Subparagraph *a*. Add the heading: *Connection Planning*. Line 3. Change "figure 6" to figure 6 or 6.1.

Subparagraph *b*. Add the heading: *Odd-numbered Extension Units* (*TS–611A/FG Only*).

Subparagraph *c*. Add the heading: *Even-Numbered Extension Units* (*TS–611A/FG Only*).

Add subparagraph *c*.1 after subparagraph *c*.

c.1. All Extension Units (*TS–611C/FG Only*). For all the extension units provided with the TS–611C/FG, use the information in B, figure 6.1. Connect terminal boards TB A and TB B of each extension unit to the appropriate terminal board (A, fig. 6.1) of the teletypewriter test set.

Subparagraph *d*. Add the heading: *Meter Circuit Connections*.

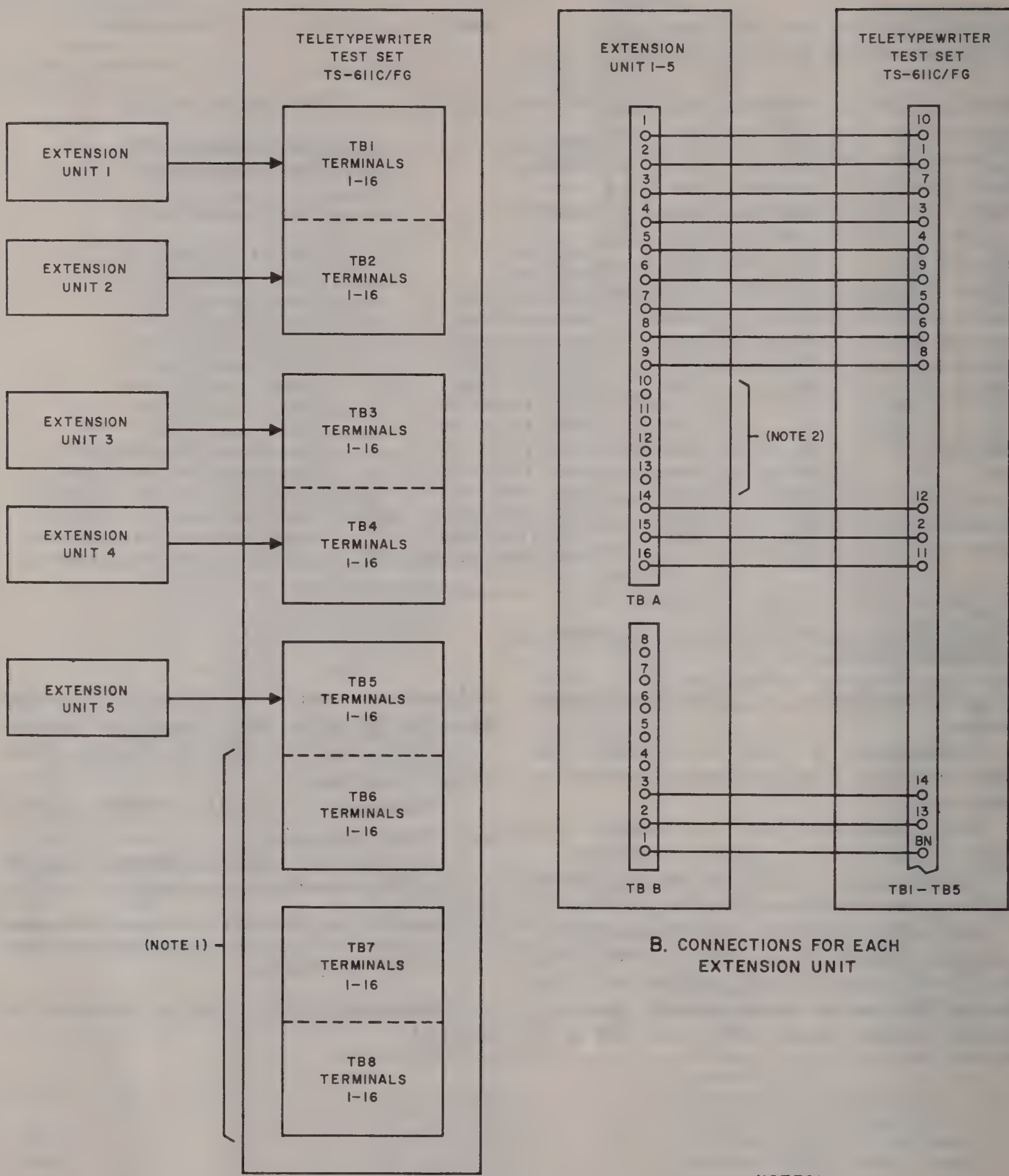
Subparagraph *e*. Add the heading: *Additional Strap Connections*.

Paragraph 19. Make the following changes:
Add the following note beneath the heading:

Note. On the TS–611C/FG, the strap connections given in *a* below are made at terminal board TB A and relay L.

Subparagraph *a*(3). Change "tetrminal" to terminal.

Page 14. Add figure 6.1 after figure 6.



A. CONNECTON PLANNING LAYOUT

NOTES:

1. FIVE EXTENSION UNITS ARE SUPPLIED. EXTENSION RELAY CIRCUITS ARE SUPPLIED WITH TERMINAL BOARDS TB1 THROUGH TB7.
2. THESE TERMINALS PROVIDE SERIES CONNECTION FOR EXTENSION UNIT METERS.

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Figure 6.1. (Added) *Connections between extension units and teletypewriter test set* (*TS-611C/FG only*).

Page 15, figure 7. Add the following note:

NOTE:

IN THE TS–611C/FG, THE TERMINAL BOARDS IN THE EXTENSION UNITS ARE DESIGNATED TB A; IN THE TELETYPEWRITER TEST SET, TB1 AND TB2 ARE REDESIGNATED TB A AND TB B, RESPECTIVELY.

Page 16, figure 8. Make the following changes:

Change NOTE to NOTES.

Designate the existing note 1.

Add the following:

2. ON THE TS–611C/FG, WIRING OPTIONS ARE MADE AT TERMINAL BOARD TB A AND RELAY L.

Paragraph 24. Add the following note beneath the heading:

Note. On the TS–611C/FG, strap terminals 31 and 32 of TB B, unless a fuse to ground is used (fig. 59.1).

Page 17, figure 9. Add to the notes:

3. ON THE TS–611C/FG, TB1 IS REDESIGNATED TB A.

Page 18, figure 10. Add to the notes:

3. ON THE TS–611C/FG, TB1 IS REDESIGNATED TB A.

Page 19, figure 11. Add the following note:

NOTE:

ON THE TS–611C/FG, TB2 IS REDESIGNATED TB B.

Page 21, paragraph 27*c*. Make the following changes:

Change the subparagraph *c* heading to: *DISTRIBUTOR Panel and 75 SPEED Panel* (fig. 14 and 14.1).

In the "Control" column, after SPEED switch add (TS–611A/FG only).

In "Function" column, make the following changes:

Line 8 relative to ORIENT potentiometers. Add after "tested": On the TS–611C/FG, this control is not used when 75-wpm circuits are being tested; the ORIENT potentiometer, on the 75 SPEED panel (TS–611C/FG only), controls the timing of the grounding intervals for the measuring capacitors (relative to the start pulse transition) when 75-wpm circuits are being tested. Line 8 relative to FINE switches. Add after "tested": On the TS–611C/FG this switch is not used when 75-wpm circuits are being tested; the FINE switch, on the 75 SPEED panel (TS–611C/FG only), provides a *fine* adjustment of the oscillator frequency, that controls the timing of the grounding intervals for the measuring capacitors, when 75-wpm circuits are being tested.

Line 8 relative to COARSE switches. Add after "tested":

On the TS–611C/FG this switch is not used when 75-wpm circuits are being tested; the COARSE switch, on the 75 SPEED panel (TS–611C/FG only), provides a coarse adjustment of the oscillator frequency, that controls the timing of the grounding intervals for the measuring capacitor, when 75-wpm circuits are being tested. Line 8 relative to DECR potentiometers. Add after "tested": On the TS–611C/FG this potentiometer is not used when 75-wpm circuits are being tested; the DECR potentiometer, on the 75 SPEED panel (TS–611C/FG only), controls the amplitude of the oscillator voltage, that controls the timing of the grounding intervals for the measuring capacitors, when 75-wpm circuits are being tested.

Page 22, figure 13. Add the following note to figure 13:

NOTE:

DIFFERENCES IN TUBE TYPES AND REFERENCE DESIGNATORS BETWEEN THE TS–611A/FG AND TS–611C/FG ARE GIVEN IN PARAGRAPH 16*b*.

Figure 14. Add the following notes to figure 14:

NOTES:

1. SPEED SW. NOT PROVIDED ON THE TS–611C/FG.
2. DIFFERENCES IN TUBE TYPES AND REFERENCE DESIGNATORS BETWEEN THE TS–611A/FG AND TS–611C/FG ARE GIVEN IN PARAGRAPH 16*b*.

Add figure 14.1.

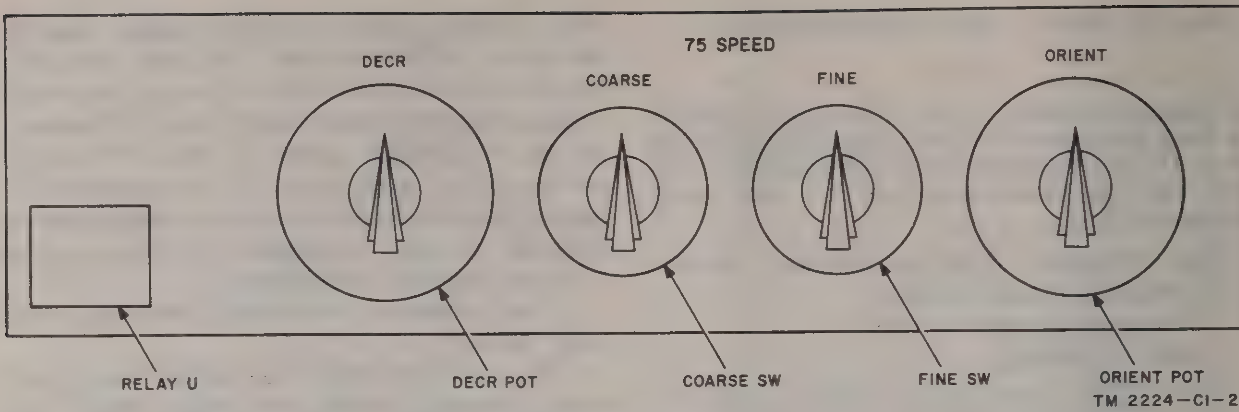

Figure 14.1. (Added) *75 SPEED panel, front view* (*TS–611C/FG only*).

Page 23, paragraph 27*d*. Make the following changes:

Change the subparagraph *d* heading to *Jack and Switch Panel* (fig. 15 or 15.1).

In the "Control" column after CHG SPD switch, add (TS–611A/FG Only).

Add the following after the information for the CHG SPD switch:

60–75–100 speed switch (TS–611C/FG only).	In nonoperated position (indicator bar vertical), arranges the teletypewriter test set for operation with 75-wpm circuits. In counterclockwise (ccw) operated position (indicator bar set toward 60), arranges the teletypewriter test set for operation with 60-wpm circuits. In clockwise (cw) operated position (indicator bar set toward 100), arranges the teletypewriter test set for operation with 100-wpm circuits.

Page 24. Add figure 15.1.

Paragraph 28. Make the following changes:

Beneath the heading, change (fig. 16) to (fig. 16 or 16.1).

Subparagraph *b*. Change the heading to *SPD Switch* (*TS–611A/FG Only*).

Add subparagraph *b.1*.

b.1. 60–75–100 Speed Switch (*TS–611C/FG Only*) (Added). The 60–75–100 speed switch (fig. 16.1) performs the same function as the 60–75–100 speed switch on the teletypewriter test set (par. 27*d*).

Page 25. Add figure 16.1.

Page 26, paragraph 29. Make the following changes:

Subparagraph *b*(1), line 2: Change "0 to 40-volt scale" to 0 to 400-volt scale.

Subparagraph *c*(1), line 2: Change "0 to 40-volt scale" to 0 to 400-volt scale.

Subparagraph *d*. Change the heading to *24-Volt Dc Supply* (*TS–611A/FG Only*).

Add the following note beneath the heading:

Note. No adjustment is provided on the TS–611C/FG.

Paragraph 30. Make the following changes:

Heading. Change (fig. 12 through 15) to (fig. 12 through 15.1).

Subparagraph *a*(1), line 1. Add before "Set": (*TS–611A/FG only*).

Add after subparagraph *a*(1):

(1.1) (*TS–611C/FG only*) (added). Set the POL and .020A switches so that the white line on each switch control is in a horizontal position. Set 60–75–100 speed switch to the 60 position.

Page 28, paragraph 31. Make the following changes:

Heading. Change (figs. 12–15) to (fig. 12–15.1).

Subparagraph *a*(1), line 1. Add before "Set": (*TS–611A/FG only*).

Add subparagraph (1.1).

(1.1) (*TS–611C/FG only*) (added). Set the POL and .020A switches so that the white line on each switch control is in a horizontal position. Set 60–75–100 speed switch to the 60 position.

Subparagraph *c*(12), *note*. Change last line to read: on the right half of the DISTRIBUTOR

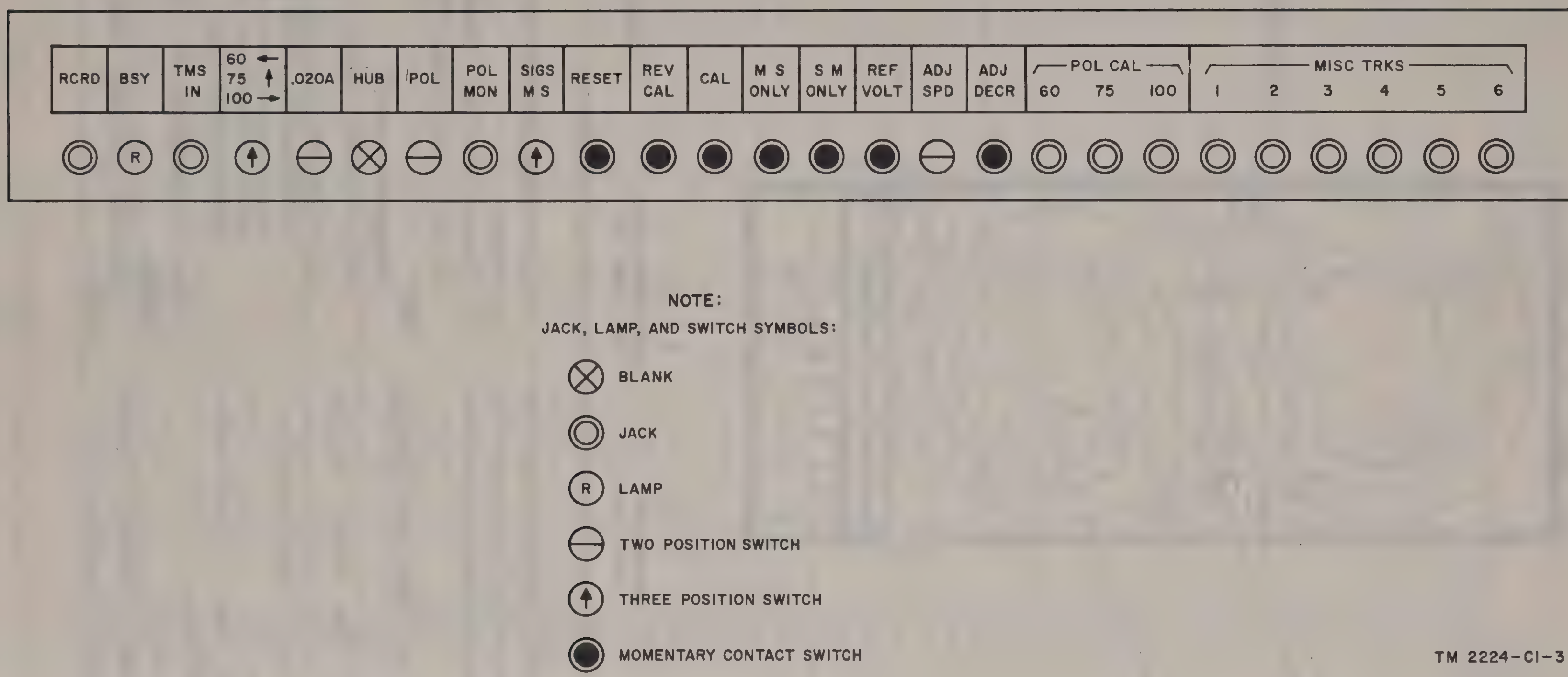

Figure 15.1. (Added) *Jack and switch panel, front view (TS-611C/FG only).*

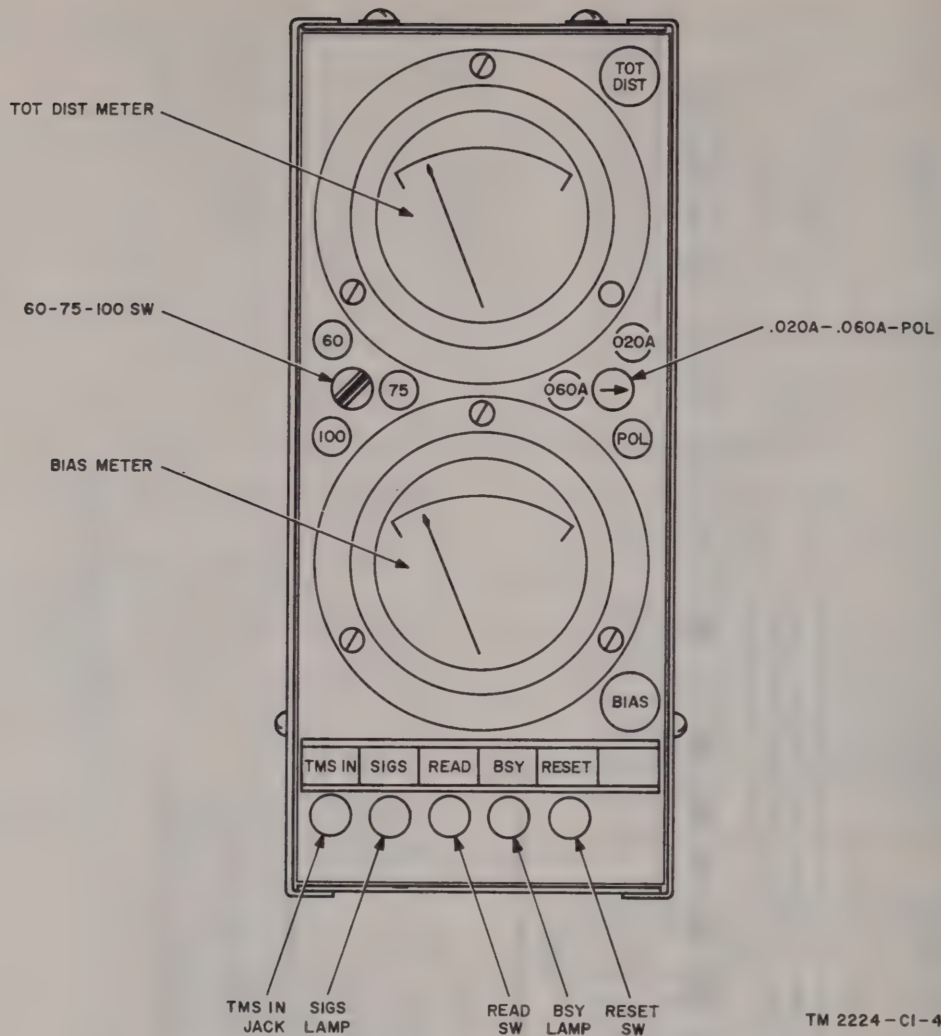

Figure 16.1. (Added) *Extension unit, front view (TS–611C/FG).*

panel. In the TS–611C/FG, a common label (60 SPEED) appears at the top of the main DISTRIBUTOR panel above this group of switches and potentiometers.

Page 29, paragraph 32. Make the following changes:

Heading. Change "(figs. 12–15)" to: (fig. 12–15.1).

Subparagraph *a*(2), line 1. Add before "Set": (*TS–611A/FG only*).

Subparagraph *a*(4), line 1. Add before "Operate": (*TS–611A/FG only*).

Add subparagraph (4.1).

(4.1). (*TS–611C/FG only*). (Added). Operate the 60–75–100 speed switch to position 75.

Page 30, paragraph 32*c*(12). Make the following changes:

Change "*Note*" to: "*Notes*".

In line 1, add before "The" (*TS–611A/FG only*).

Designate the note "1".

Add note 2 after note 1:

2. (*TS–611C/FG only*). The COARSE and FINE switches and the DECR and ORIENT potentiometers, referred to in *d* through *f* below, are on the 75 SPEED panel located below the main DISTRIBUTOR panel.

Page 31, paragraph 33. Make the following changes:

Heading. Change "(figs. 12–15)" to: (fig. 12–15.1).

CHART 2.1

TYPE OF CIRCUIT OPERATION				REQUIRED SWITCH SETTINGS AT EXTENSION UNITS	
SPEED (WPM)	CURRENT (MA)	CODE UNITS	TYPE OF SIGNAL	.020A-.060A-POL	60-75-100 SPEED
60	60	5	NEUTRAL	←	\
66	60	5	NEUTRAL	←	\
75	60	5	NEUTRAL	←	|
100	60	5	NEUTRAL	←	/
60	20	5	NEUTRAL	↑	\
66	20	5	NEUTRAL	↑	\
75	20	5	NEUTRAL	↑	|
100	20	5	NEUTRAL	↑	/
60	60	6	NEUTRAL	←	\
66	60	6	NEUTRAL	←	\
75	60	6	NEUTRAL	←	|
100	60	6	NEUTRAL	←	/
60	20	6	NEUTRAL	↑	\
66	20	6	NEUTRAL	↑	\
75	20	6	NEUTRAL	↑	|
100	20	6	NEUTRAL	↑	/
60	30	5	POLAR	↓	\
66	30	5	POLAR	↓	\
75	30	5	POLAR	↓	|
100	30	5	POLAR	↓	/
60	30	6	POLAR	↓	\
66	30	6	POLAR	↓	\
75	30	6	POLAR	↓	|
100	30	6	POLAR	↓	/

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Figure 18.1. (Added) *Switch setting chart for extension units (TS-611C/FG only).*

672510 O—63——2

Subparagraph *a*(2), line 1. Add before "Set": (*TS–611A/FG only*).

Subparagraph *a*(4), line 1. Add before "Operate": (*TS–611A/FG only*).

Add subparagraph *a*(4.1).

(4.1) (*TS–611C/FG*) (added). Operate the 60–75–100 speed switch to position 100.

Subparagraph *c*(12), note. After the last line, add: In the TS–611C/FG, a common label (100 SPEED) appears at the top of the DISTRIBUTOR panel above this group of switches and potentiometers.

Page 34, paragraph 36*b*(2), last line. Change "chart 2 (fig. 18)" to: for the TS–611A/FG (fig. 18) or chart 2.1 for the TS–611C/FG (fig. 18.1).

Page 35. Add figure 18.1.

Page 43, paragraph 55, chart. Make the following changes:

In "Item" column, after CHG SPD switch, add (TS–611A/FG only).

Add after "Item No. 3":

Item No.	Item	Action or condition
3. 1	60–75–100 speed switch (TS–611C/FG only).	Set to position 60.

In "Item" column after SPEED switch add (TS–611A/FG only).

Page 44, paragraph 55, chart, "Item No. 17", "Corrective measures" column. After "level is required" add

Note. Resistor R601 is not used in the TS–611C/FG.

Page 45, paragraph 55, chart. Make the following changes in the "Corrective measures" column for the items indicated:

"Item No. 25". After "maintenance is required," add:

Note. Tubes V303 and V304 are designated C and D, respectively, in the TS–611C/FG.

"Item No. 27". After "is required" add:

Note. Polar relays K2, K4, and K5 are designated A (REC), C, and D, respectively, in the TS–611C/FG.

"Item No. 28". After "maintenance level is required," add:

Note. Tubes V301 and V302 are replaced by diodes VR11 and VR12 in the TS–611C/FG.

"Item No. 30". After "required," add

Note. Tubes V301 and V302 are replaced by diodes VR11 and VR12 in the TS–611C/FG.

Page 46, paragraph 55, chart: "Item No. 35", in "Corrective measures" column following sentence "Replace relay K3." add:

Note. Tube V301 is replaced by diode VR11, tube V203 is designated D, and relay K3 is designated B in the TS–611C/FG.

Page 48, paragraph 56. Add paragraph 56.1.

56.1. Cross-Reference Designations Between TS–611A/FG and TS–611C/FG

(Added)

Teletypewriter Test Sets TS–611A/FG and TS–611C/FG use the same circuitry in most respects and utilize similar parts. However the circuit reference designators differ. The following chart identifies the parts in the various units and supplies the cross-reference designations for each part in each model of the equipment.

Note. The theoretical analysis of the TS–611A/FG described in paragraphs 57 through 113 is also applicable to the TS–611C/FG when the proper component reference designation is substituted. Where circuitry in the TS–611C/FG is different, it is explained in detail.

Unit	Reference designators	
	TS-611A/FG	TS-611C/FG
PWR SUP panel.	Capacitors:	Capacitors:
	C101	A
	C102	B
	Inductor:	Inductor:
	L101	A
	Resistors:	Resistors:
	R101	A
	R102	B
	R103	C
	R104A	D
	R104B	
	R105	E
	R106	F
	R107	G
	R108	H
	R109	BIAS
	R110	AMP ADJ
	R111	ZERO ADJ
	R112	REF VOLT
	R113	SC VOLT
	R114	CONST CUR
	Terminal board:	Terminal board:
	TB1	TB
	Transformer:	Transformer:
	T101	A

Unit	Reference designators	
	TS-611A/FG	TS-611C/FG
PWR SUP panel—Con.	Electron tubes:	Electron tubes:
	V101	A
	V102	B
	V103	C
	V104	D
	V105	E
	V106	F
DISTRIBUTOR panel.	Capacitors:	Capacitors:
	C201	A
	C202	
	C203	B
	C204	
	C205	C
	C206	D
	C207	E
	C208	F
	C209	
	C210	G
	C211	
	C212	H
	C213	J
	C214	K
	C215	L
	C216	M
	C217	N
	C218	P
	C219	R
	C220	Y
	C221	S
	C222	T
	C223	U
	C224	V
	C225	W
	C226	X
	C228	Z1
	C229	Z2
	C230	AB
	C231	AC
		AD
		AE
		AF
		AG1
		AG2
	Diodes:	Diodes:
	CR201	VR1
	CR202	VR2
	CR203	VR3
	CR204	VR4
	CR205	VR5
	CR206	VR6
	CR207	VR7
	CR208	VR8
	CR209	VR9
	CR210	VR10

Unit	Reference designators	
	TS-611A/FG	TS-611C/FG
DISTRIBUTOR panel—Continued	Inductors:	Inductors:
	L201	B
	L202	C
	L203	D
	Relays:	Relays:
	K201	M
	K202	N
	K203	P
		U
	Resistors:	Resistors:
	R201	A
	R202	C
	R203	D
	R204	E
	R205	F
	R206	H
	R207	J
	R208	L
	R209	M
	R210A	P
	R210B	
	R211	ORIENT 100
	R212	CHAR
	R213	ORIENT 60
	R214	DECR 100
	R215	DECR 60
	R216	AB
	R217	AC
	R218	AD
	R219	AE
	R220	AF
	R221	AG
	R222	AH
	R223	AJ
	R224	B
	R225	AK
	R226	AL
	R227	AM
	R228	AN
	R229	AO
	R230	AP
	R231	AQ
	R232	AR
	R233	AS
	R234	AT
	R235	AU
	R236	AA
		AV
		ORIENT 75 [a]
		DECR 75 [a]
	Switches:	Switches:
	S201	
	S202	FINE (100 SPEED)
	S203	COARSE (100 SPEED)

Unit	Reference designators	
	TS-611A/FG	TS-611C/FG
DISTRIBUTOR panel—Continued	Switches—Con.	Switches—Con.
	S204	FINE (60 SPEED)
	S205	COARSE (60 SPEED)
	S206	CODE 6–5
	----------------	FINE (75 SPEED)[2]
	----------------	COARSE (75 SPEED)[2]
	Terminal board:	Terminal board:
	TB201	TB
	Transformer:	Transformer:
	T201	A
	Electron tubes:	Electron tubes:
	V201	
	V202	B
	V203	D
	V204	E
	V205	F
RECT PEAK VM panel.	Capacitors:	Capacitors:
	C301	A
	C302	B
	C303	C
	C304	D
	C305	E
	Diodes:	Diodes:
	----------------	VR11
	----------------	VR12
	Inductor:	Inductor:
	L301	A
	Relay:	Relay:
	K301	A
	Resistors:	Resistors:
	R301A	
	R301B	
	R302	E
	R303	D
	R304	C
	R305	O
	R306	N
	R307	M
	R308	A
	R309	W
	R310	V
	R311	H
	R312	X
	R313	G
	R314	B
	R315	R
	R316	S
	R317	T
	R318	U
	R319	K
	R320	L
	R321	P
	R322	Q

Unit	Reference designators	
	TS-611A/FG	TS-611C/FG
RECT PEAK VM panel—Continued	Electron tubes:	Electron tubes:
	V301	
	V302	
	V303	C
	V304	D
	Terminal board:	Terminal board:
	TB301	TB
	Transformers:	Transformers:
	T301	A
	T302	B
24 VOLT SUP panel.	Capacitors:	Capacitors:
	C601	C1
	C602	
	Diode:	Diode:
	CR601	VR1
	Fuses:	Fuses:
	F601	J
	F602	
	F603	
		A
		B
		C
		D
		E
		F
		G
		H
	Resistors:	Resistor:
	R601	
	R32	A
	Terminal board:	
	TB601	
Meter panel	Meters:	Meters:
	M1	BIAS
	M2	TOTAL DIST
	M3	CONST CUR
	M4	SC REF VOLTS
	Resistors:	Resistors:
	R22A	AW
	R22B	AX
Jack and switch panel.	Jacks:	Jacks:
	J1	RCRD
	J2	TMS IN
	J3	POL MON
	J4	60–POL CAL
	J5	75–POL CAL
	J6	100–POL CAL
	J7	MISC TRKS–1
	J8	MISC TRKS–2
	J9	MISC TRKS–3
	J10	MISC TRKS–4
	J11	MISC TRKS–5
	J12	MISC TRKS–6
	Resistor:	Resistor:
	R24	V

Unit	Reference designators	
	TS-611A/FG	TS-611C/FG
Jack and switch panel—Con.	Switches:	Switches:
	S1	
	S2	.020A
	S3	POL
	S4	SIGS
	S5	RESET
	S6	REV CAL
	S7	CAL
	S8	MS ONLY
	S9	SM ONLY
	S10	REF VOLT
	S11	ADJ SPEED
	S12	ADJ DECR 60–75–100
	Lamp:	Lamp:
	E1	BSY
COMP CKT panel.	Capacitors:	Capacitors:
	C1)	E
	C2)	
	C3)	A
	C4)	B
	C5)	C
	C6)	
	C7)	
	C8)	
	C9)	
	C10)	
	C11)	D
	C12)	
	C13)	
	C14)	
	C15)	
	C16)	
	Diode:	Diode:
	CR1	A
	Relays:	Relays:
	K1	SC
	K2	A(REC)
	K3	B
	K4	C
	K5	D
	K6	E
	K7	F
	K8	G
	K9	H
	K10	K
	K11	L
	K12	S
	K13	R
	Resistors:	Resistors:
	R1B	C
	R2A)	D
	R2B)	
	R3	E
	R4	F
	R5A	G
COMP CKT panel—Con.	Resistors—Con.	Resistors—Con.
	R6A	H
	R7	K
	R8A	L
	R8B	
	R9	M
	R10A	N
	R10B	
	R11	P
	R12	R
	R13	S
	R14	T
	R15	U
	R16A	X
	R16B	
	R17	Y
	R18	Z
	R19	AR
	R20	A
	R21A	B
	R21B	
	R25	
	R26	
	R27	
	R28	
	R29	
	R30	
	R31	
EXT CKT panels.	Relays [b]:	Relays:
	K15	B
	K16	A
	K17	C
	K18	A
	K19	C
	K20	A
	K21	C
	K22	A
	K23	C
	K24	A
	K25	C
	Terminal boards:	Terminal boards:
	TB3	TB1
	TB3	TB2
	TB4	TB3
	TB4	TB4
	TB5	TB5
	TB5	TB6
	TB6	TB7
	TB1	TB A
	TB2	TB B
Extension units	Jack:	Jack:
	J701	TMS IN
	Lamps:	Lamps:
	E701	BSY
	E702	SIGS
	Meters:	Meters:
	M701	BIAS
	M702	TOT DIST

Unit	Reference designators	
	TS–611A/FG	TS–611C/FG
Extension units—Continued	Resistor:	Resistor:
	R701	D
	Switches:	Switches:
	S701	READ
	S702	RESET
	S704	.020A–.060A–POL
	S703	60–75–100
	Terminal boards:	Terminal boards:
	TB701	TB A
	TB702	TB B

[a]Components mounted on 75 SPEED panel in the TS–611C/FG.
[b]Relays K26 through K45 in the TS–611A/FG have no equivalents in the TS–611C/FG.

Page 52, paragraph 61, line 6. After "maximum of 15" add: on the TS–611A/FG and a maximum of 7 on the TS–611C/FG.

Page 54, paragraph 68. Make the following changes:

Subparagraph *a*(2), chart. After the chart add:

> *Note.* A maximum of seven extension units may be used in the TS–611C/FG.

Subparagraph *b*, line 5. Make the following changes:

Change (fig. 25) to (fig. 25 or 25.1).

Line 6. Change (fig. 73) to (fig. 73 or 73.1).

Page 58, paragraph 72, line 5. Change (figs. 23 and 26) to (figs. 23 and 26 or 26.1).

Add figure 25.1.

Page 59, paragraph 72. Make the following changes:

Line 7. Change (fig. 26) to (fig. 26 or 26.1).

Line 10. Change (fig. 25) to (fig. 25 or 25.1).

Line 11. Change (fig. 73) to (fig. 73 or 73.1).

Paragraph 73. Make the following changes:

Heading. Change (fig. 26) to (fig. 26 or 26.1).

Subparagraph *b*(3), line 1. Add before "The": (*TS–611A/FG Only* (fig. 26)).

Add subparagraph (3.1).

(3.1) (*TS–611C/FG Only* (fig. 26.1)) (added). The condition for the conduction in tube B is as follows: The grid of tube B (pin 5) is returned to the +130-volt supply through the CHAR potentiometer, resistors AB and AC, and the CODE switch. The grid potential is approximately ground because of grid limiting due to the large resistance in this circuit. The screen grid of tube B (pin 4) is at a potential of about 50 volts because of the voltage-divider action of resistors AP and AQ.

Page 60, paragraph 74. Make the following changes:

Heading. Change (fig. 26) to (fig. 26 or 26.1).

Subparagraph *a*, line 4. Change "K2" to K3.

Subparagraph *a*(1), line 2. Change "R7A" to R8A.

Subparagraph *e*, line 5. Change (R113) to (R114).

Add figure 26.1.

Page 61, paragraph 75*b*. Make the following changes:

Line 3. Change (fig. 23 and 26) to (fig. 23 and 26 or 26.1).

Line 5. Change (fig. 26) to (fig. 26 or 26.1).

Line 9. Change (fig. 28) to (fig. 28 or 28.1).

Line 10. Change (fig. 73) to (fig. 73 or 73.1).

Paragraph 76. Make the following changes:

Heading. Change (fig. 26) to (fig. 26 or 26.1).

Change "Note" to *Notes*.

Number the existing note 1.

In line 4 of the note, change (fig. 26) to (fig. 26 or 26.1).

Add the following note after note 1:

> 2. The equivalent of tube V201 is not used in the TS–611C/FG. Reference to tube V201 in the circuit description in *a* through *g* below pertains to the TS–611A/FG only.

Page 63, paragraph 77, heading. Change (fig. 26) to (fig. 26 or 26.1).

Paragraph 78. Make the following changes:

Heading. Change (figs. 26 and 27) to (fig. 26 or 26.1 and 27).

Subparagraph *a*, line 2. Change (fig. 26) to (fig. 26 or 26.1).

Page 64, paragraph 79, heading. Change (fig. 26) to (fig. 26 or 26.1).

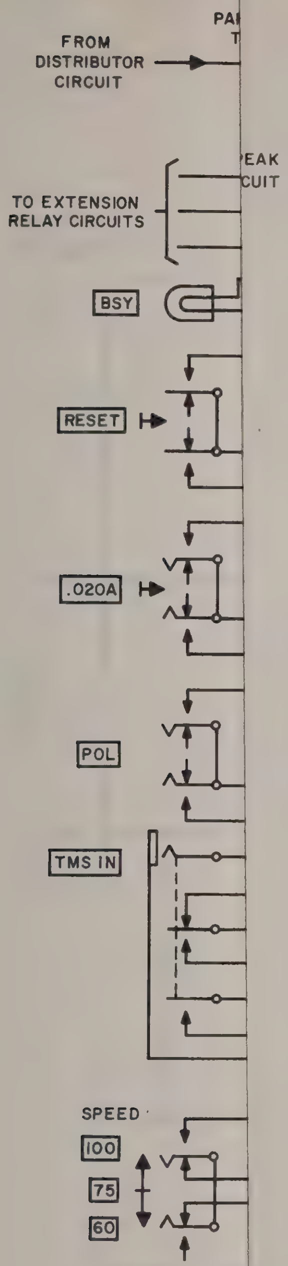
Page 66. Add figure 28.1.

Page 67, paragraph 80. Make the following changes:

Lines 3 and 4. Change the words "Two switches (CHG SPD and SPEED)" to Switches.

Paragraph 81, heading. After "Operation" add: (TS–611A/FG Only).

Add paragraph 81.1.



NOTES:

1. UNLESS OTHERWISE INDICATED, RESISTORS, AND INDUCTORS ARE IN OHMS AND CAPACITORS ARE IN UF.
2. FOR CONNECTIONS TO OTHER CIRCUITS, SEE OVERALL SCHEMATIC AND INTERCONNECTION DIAGRAMS.
3. USE OF STRAPPING OPTIONS W, X, Y, AND Z IS DETERMINED BY THE NUMBER OF EXTENSION UNITS USED WITH THE TEST SET. SEE THE CHART BELOW.

NUMBER OF EXTENSION UNITS USED	STRAPPING OPTIONS REQUIRED
NONE	W [a]
1 OR 2	NONE
3	X
4 OR 5	X AND Y
6, 7, OR 8	Y AND Z
9 OR MORE	X, Y, AND Z

[a] FACTORY INSTALLED ON NEW EQUIPMENT

4. NC DENOTES NO CONNECTION.
5. ▭ INDICATES EQUIPMENT MARKINGS.

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Unit	Reference designators	
	TS-611A/FG	TS-611C/FG
Extension units—Continued	Resistor:	Resistor:
	R701	D
	Switches:	Switches:
	S701	READ
	S702	RESET
	S704	.020A-.060A-POL
	S703	60-75-100
	Terminal boards:	Terminal boards:
	TB701	TB A
	TB702	TB B

[a]Components mounted on 75 SPEED panel in the TS-611C/FG.
[b]Relays K26 through K45 in the TS-611A/FG have no equivalents in the TS-611C/FG.

Page 52, paragraph 61, line 6. After "maximum of 15" add: on the TS-611A/FG and a maximum of 7 on the TS-611C/FG.

Page 54, paragraph 68. Make the following changes:

Subparagraph *a*(2), chart. After the chart add:

> *Note.* A maximum of seven extension units may be used in the TS-611C/FG.

Subparagraph *b*, line 5. Make the following changes:

Change (fig. 25) to (fig. 25 or 25.1).

Line 6. Change (fig. 73) to (fig. 73 or 73.1).

Page 58, paragraph 72, line 5. Change (figs. 23 and 26) to (figs. 23 and 26 or 26.1).

Add figure 25.1.

Page 59, paragraph 72. Make the following changes:

Line 7. Change (fig. 26) to (fig. 26 or 26.1).

Line 10. Change (fig. 25) to (fig. 25 or 25.1).

Line 11. Change (fig. 73) to (fig. 73 or 73.1).

Paragraph 73. Make the following changes:

Heading. Change (fig. 26) to (fig. 26 or 26.1).

Subparagraph *b*(3), line 1. Add before "The": (*TS-611A/FG Only* (fig. 26)).

Add subparagraph (3.1).

(3.1) (*TS-611C/FG Only* (fig. 26.1)) (added). The condition for the conduction in tube B is as follows: The grid of tube B (pin 5) is returned to the +130-volt supply through the CHAR potentiometer, resistors AB and AC, and the CODE switch. The grid potential is approximately ground because of grid limiting due to the large resistance in this circuit. The screen grid of tube B (pin 4) is at a potential of about 50 volts because of the voltage-divider action of resistors AP and AQ.

Page 60, paragraph 74. Make the following changes:

Heading. Change (fig. 26) to (fig. 26 or 26.1).

Subparagraph *a*, line 4. Change "K2" to K3.

Subparagraph *a*(1), line 2. Change "R7A" to R8A.

Subparagraph *e*, line 5. Change (R113) to (R114).

Add figure 26.1.

Page 61, paragraph 75*b*. Make the following changes:

Line 3. Change (fig. 23 and 26) to (fig. 23 and 26 or 26.1).

Line 5. Change (fig. 26) to (fig. 26 or 26.1).

Line 9. Change (fig. 28) to (fig. 28 or 28.1).

Line 10. Change (fig. 73) to (fig. 73 or 73.1).

Paragraph 76. Make the following changes:

Heading. Change (fig. 26) to (fig. 26 or 26.1).

Change "Note" to *Notes*.

Number the existing note 1.

In line 4 of the note, change (fig. 26) to (fig. 26 or 26.1).

Add the following note after note 1:

> 2. The equivalent of tube V201 is not used in the TS-611C/FG. Reference to tube V201 in the circuit description in *a* through *g* below pertains to the TS-611A/FG only.

Page 63, paragraph 77, heading. Change (fig. 26) to (fig. 26 or 26.1).

Paragraph 78. Make the following changes:

Heading. Change (figs. 26 and 27) to (fig. 26 or 26.1 and 27).

Subparagraph *a*, line 2. Change (fig. 26) to (fig. 26 or 26.1).

Page 64, paragraph 79, heading. Change (fig. 26) to (fig. 26 or 26.1).

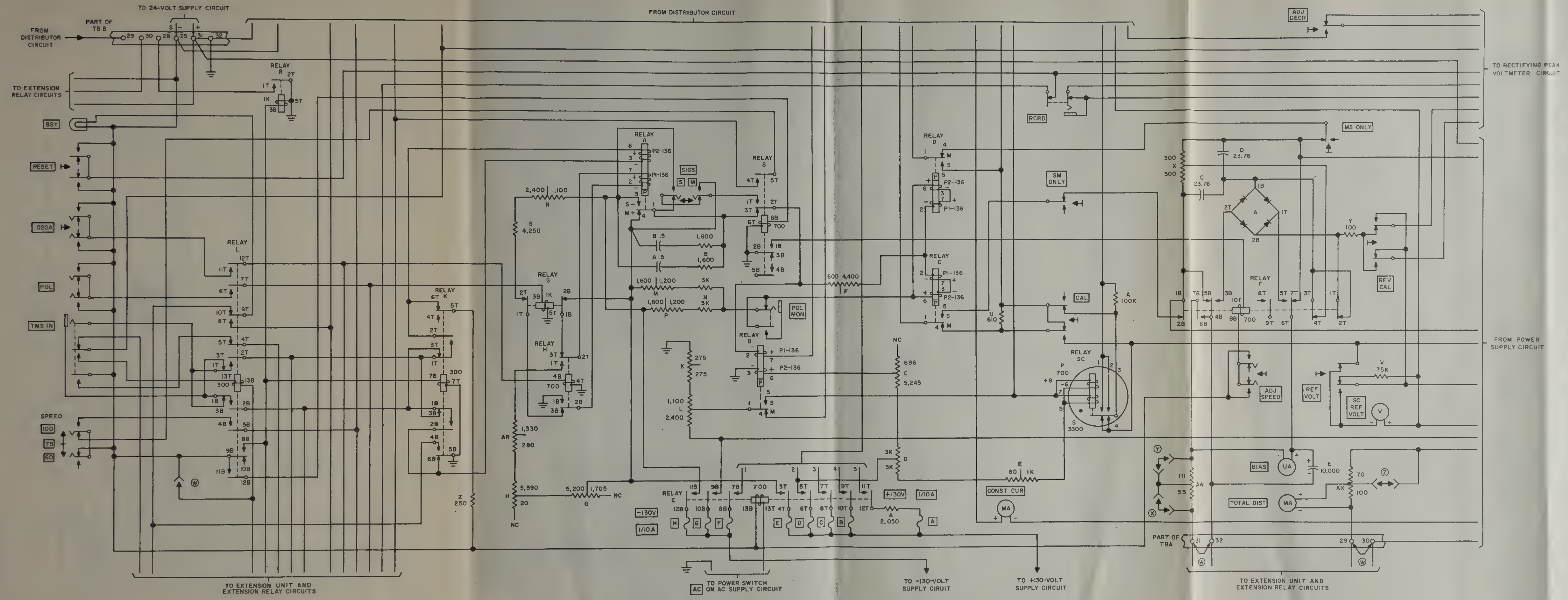
Page 66. Add figure 28.1.

Page 67, paragraph 80. Make the following changes:

Lines 3 and 4. Change the words "Two switches (CHG SPD and SPEED)" to Switches.

Paragraph 81, heading. After "Operation" add: (TS-611A/FG Only).

Add paragraph 81.1.



NOTES

1. UNLESS OTHERWISE INDICATED, RESISTORS AND INDUCTORS ARE IN OHMS AND CAPACITORS ARE IN UF
2. FOR CONNECTIONS TO OTHER CIRCUITS, SEE OVERALL SCHEMATIC AND INTERCONNECTION DIAGRAMS
3. USE OF STRAPPING OPTIONS W, X, Y, AND Z IS DETERMINED BY THE NUMBER OF EXTENSION UNITS USED WITH THE TEST SET. SEE THE CHART BELOW.

NUMBER OF EXTENSION UNITS USED	STRAPPING OPTIONS REQUIRED
NONE	W [a]
1 OR 2	NONE
3	X
4 OR 5	X AND Y
6, 7, OR 8	Y AND Z
9 OR MORE	X, Y, AND Z

[a] FACTORY INSTALLED ON NEW EQUIPMENT

4. NC DENOTES NO CONNECTION
5. ☐ INDICATES EQUIPMENT MARKINGS

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Figure 25.1 (Added) Input circuit and measuring circuit schematic diagram (TS-611C/FG only).

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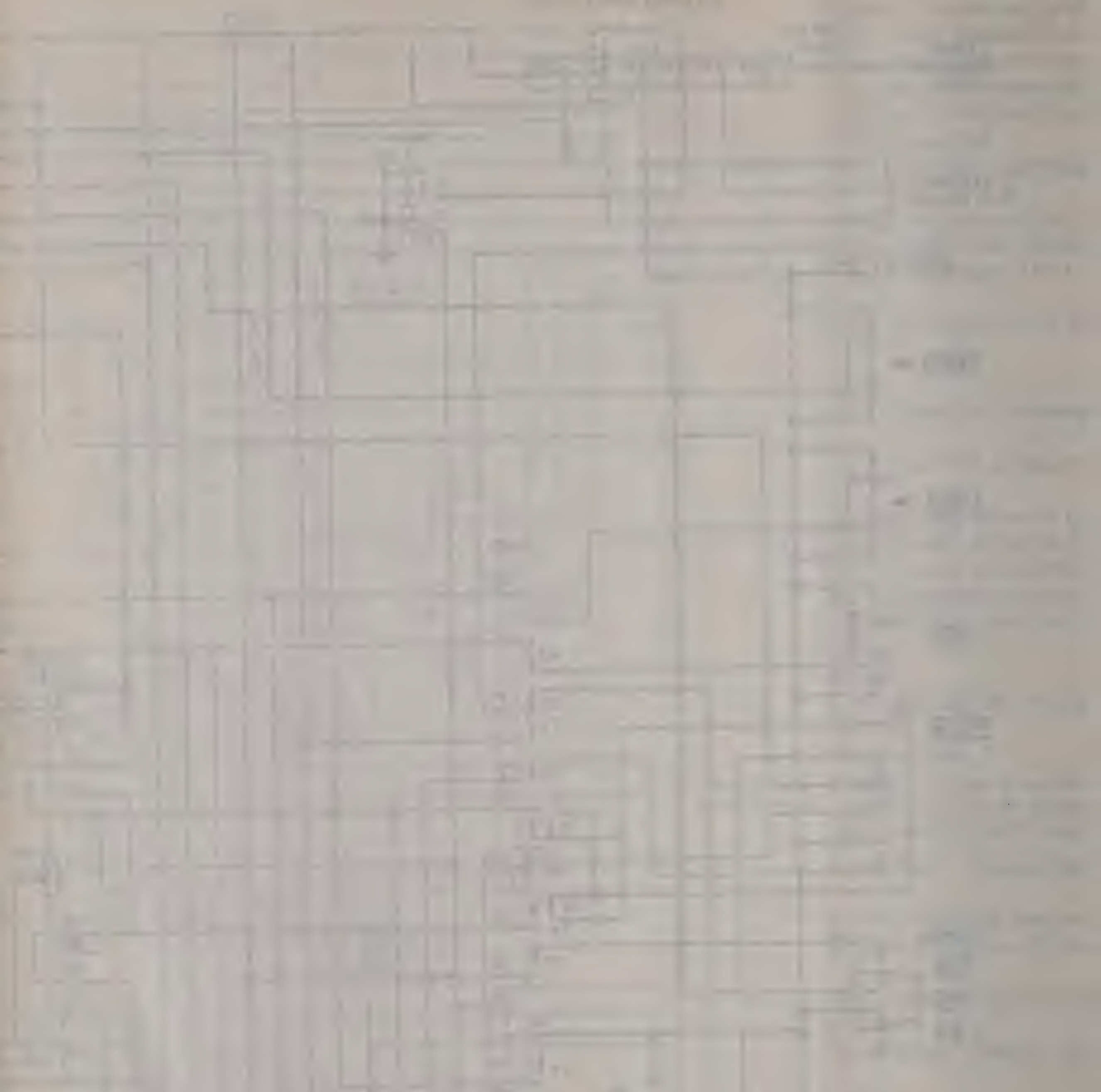
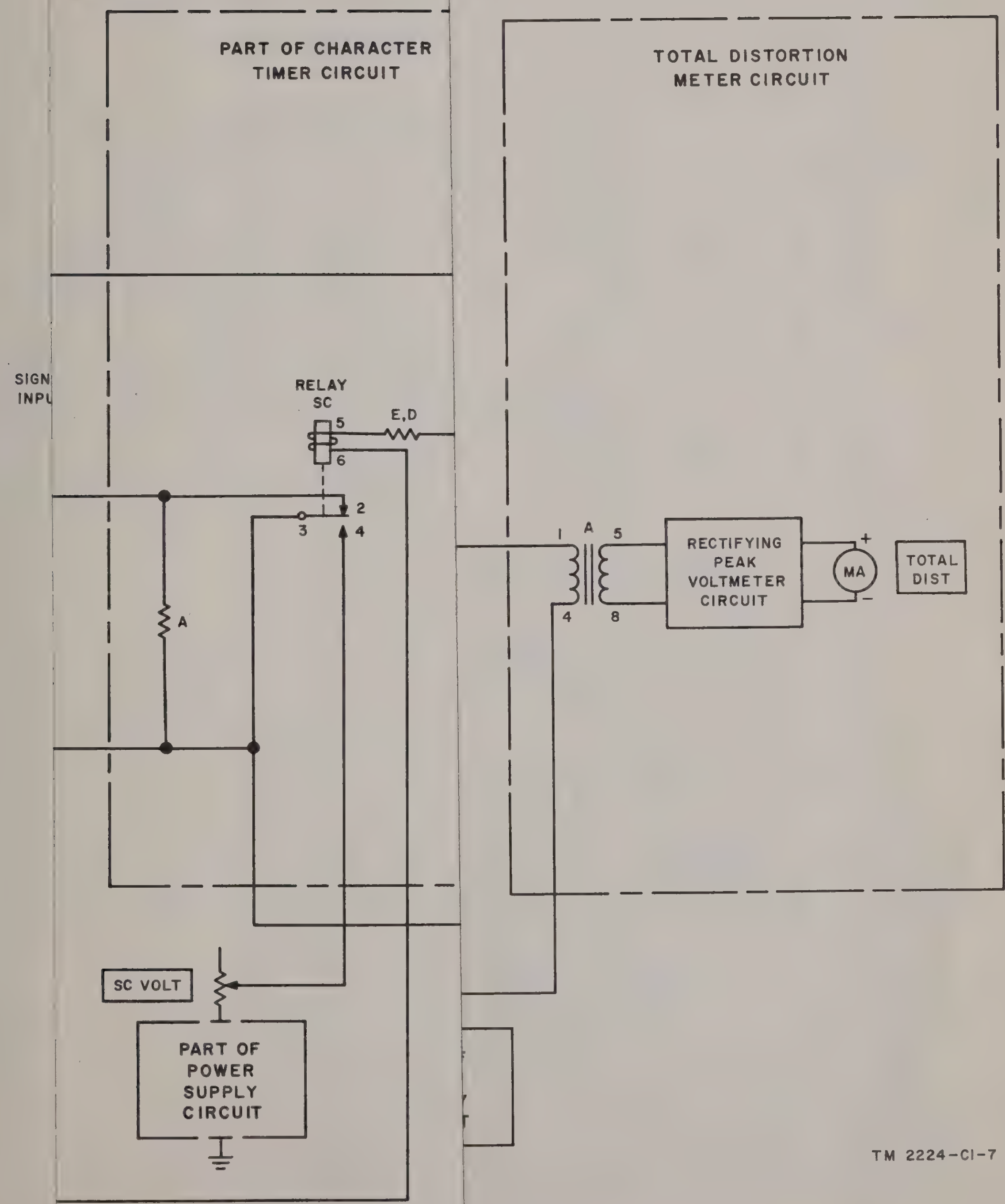


NOTES:

ᴊIT IS SHOWN IN 60 WPM SPEED POSITION.

INDICATES EQUIPMENT MARKING.



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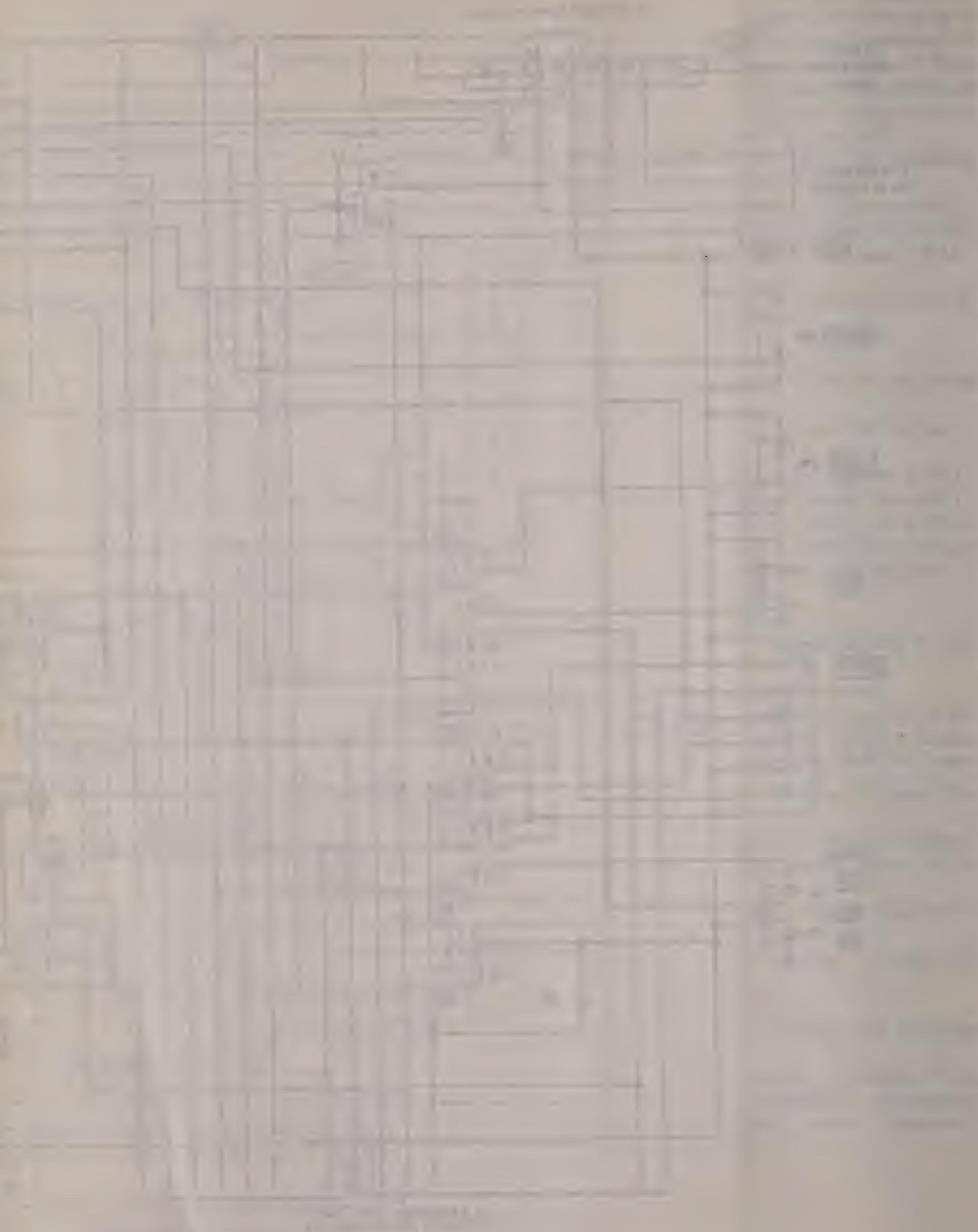
672510 O - 63 (Face p. 14) No. 2



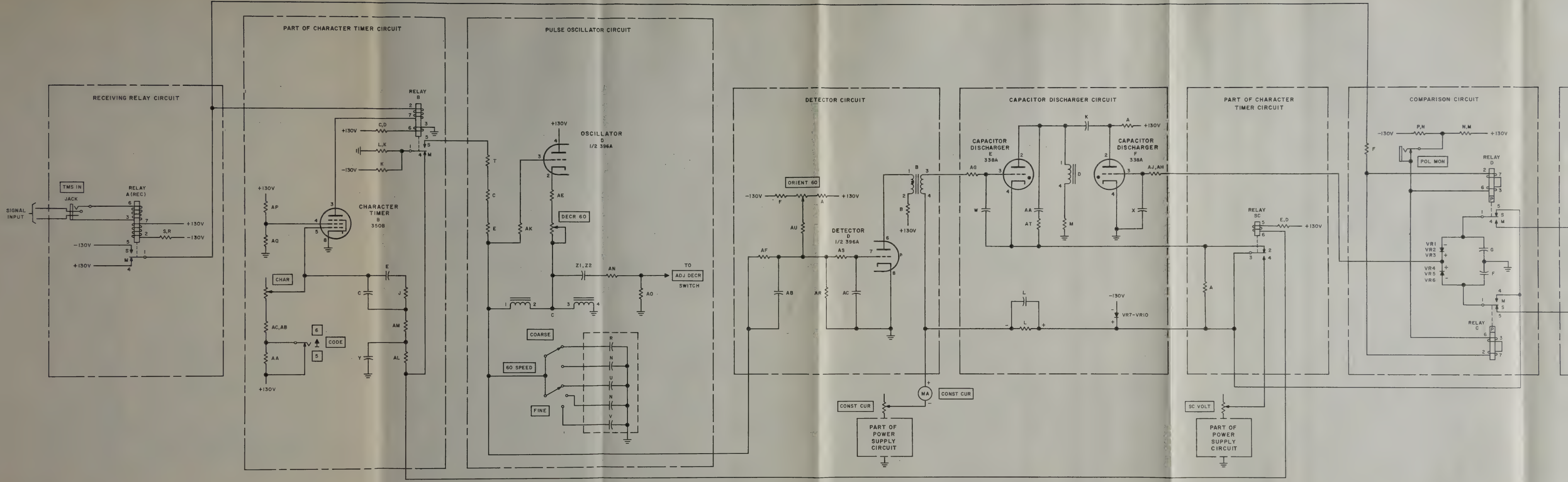


Figure 26.1. (Added) *Input, distributor, and measuring circuits, simplified schematic diagram (TS-611C/FG only).*

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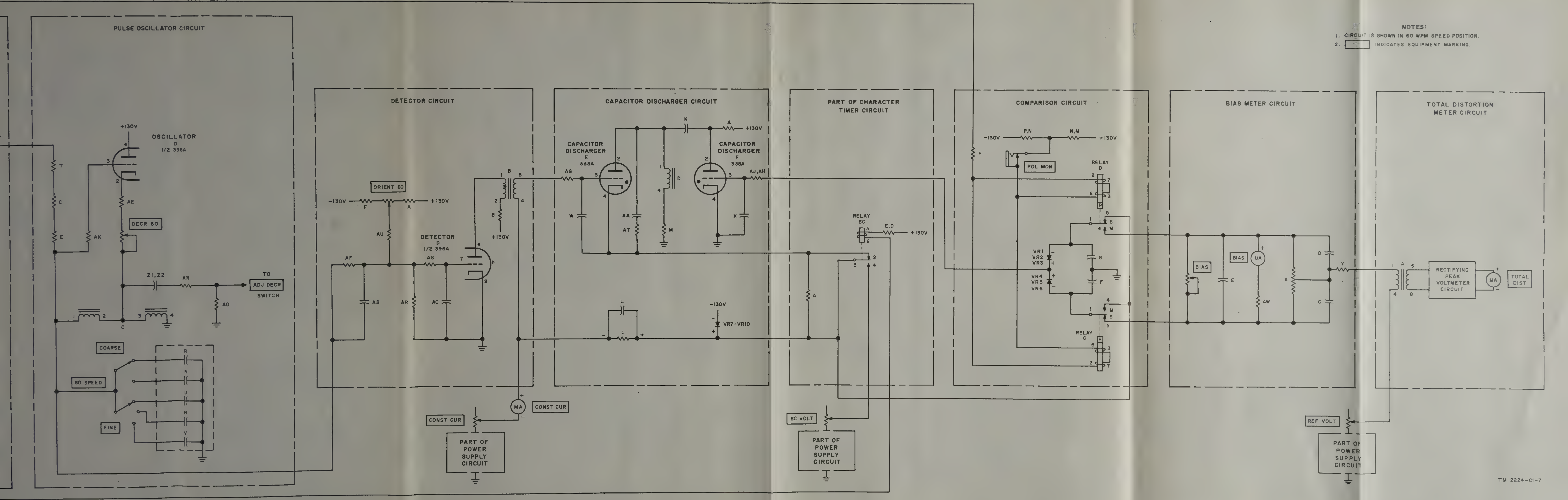
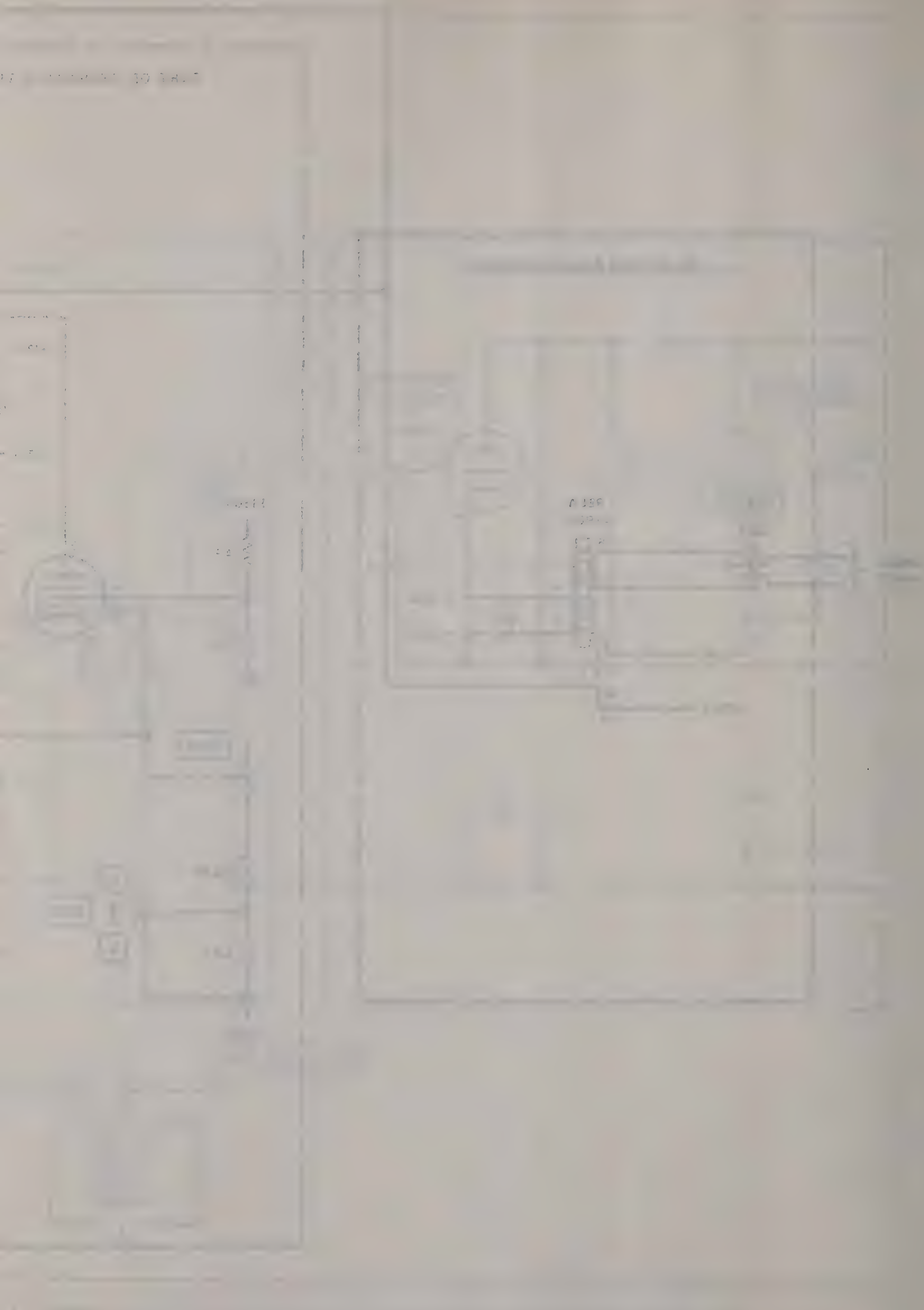
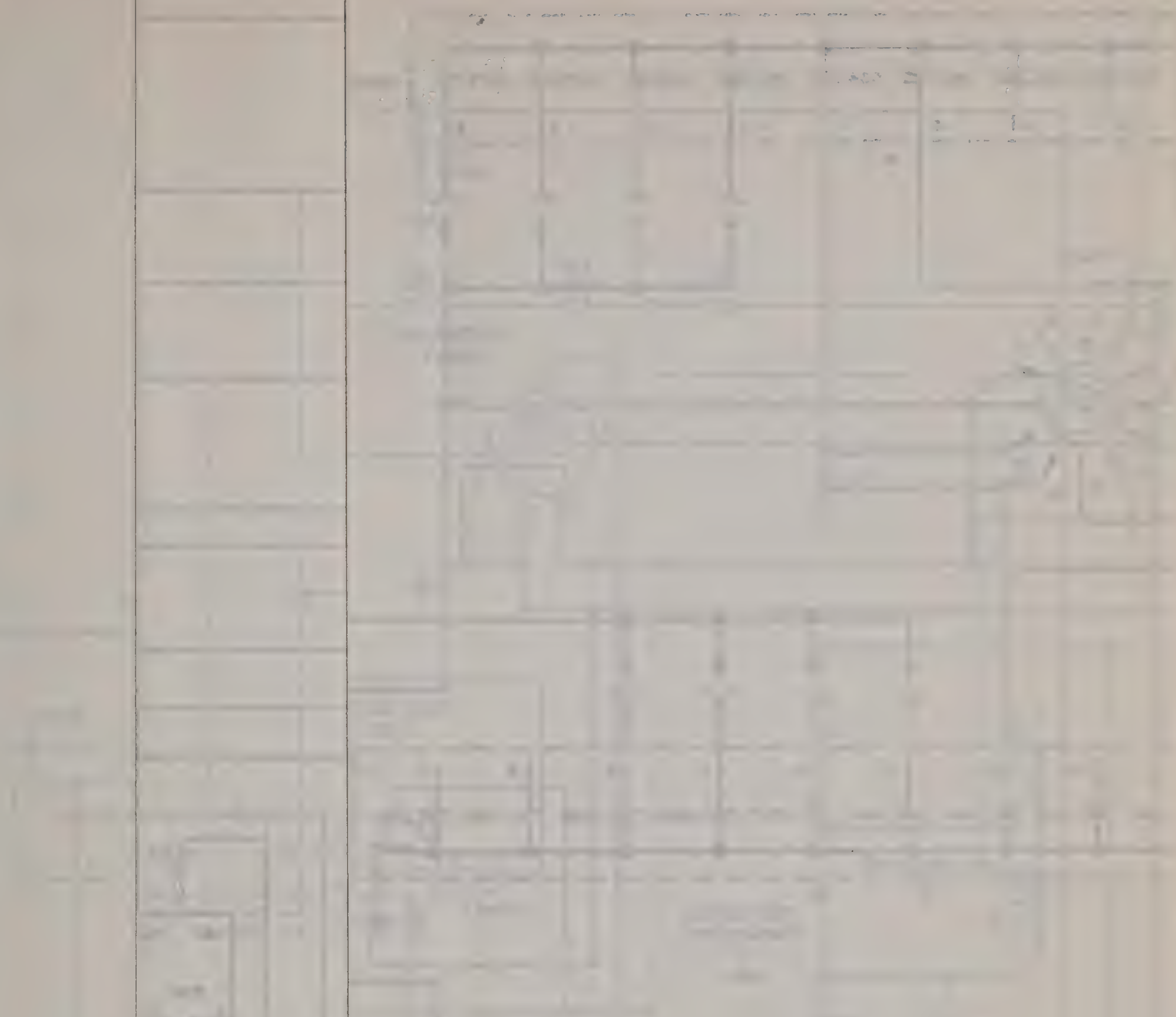
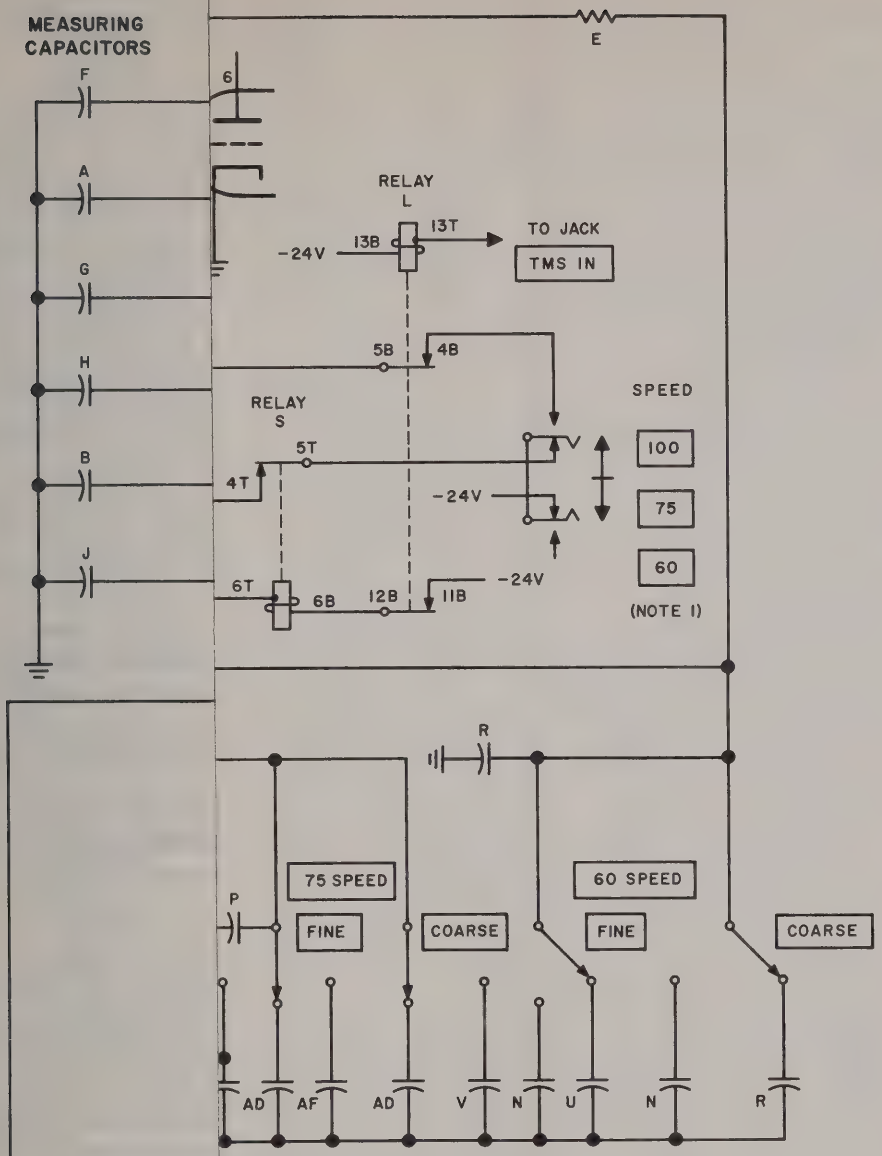


Figure 26.1. (Added) *Input, distributor, and measuring circuits, simplified schematic diagram (TS-611C/FG only).*







TO CONTA
OF RELAY

FROM CONTA
OF RELAY

NOTES:

RELAY CONDITIONS:

SWITCH AND RELAY CONDITIONS					
SPEED SWITCH	RELAY M	RELAY N	RELAY P	RELAY U	REMARKS
60	UNOPERATED	UNOPERATED	UNOPERATED	UNOPERATED	RELAYS L AND S ARE HELD OPERATED BY JACK TMS IN
75	OPERATED	OPERATED	OPERATED	OPERATED	
100	UNOPERATED	OPERATED	OPERATED	UNOPERATED	

HOWN FOR 75 SPEED.

4. ☐ INDICATES EQUIPMENT MARKINGS.

NO CONNECTION.

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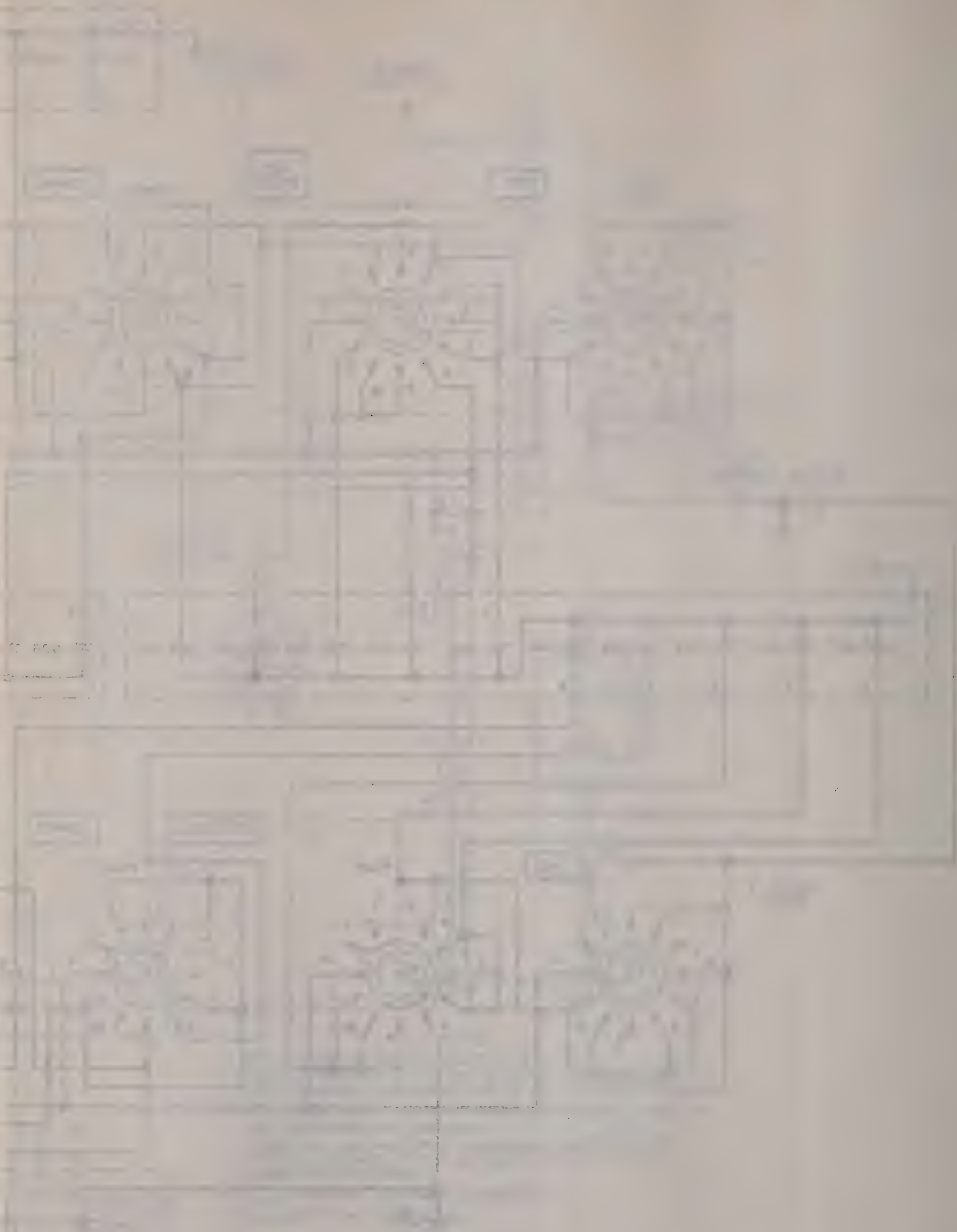


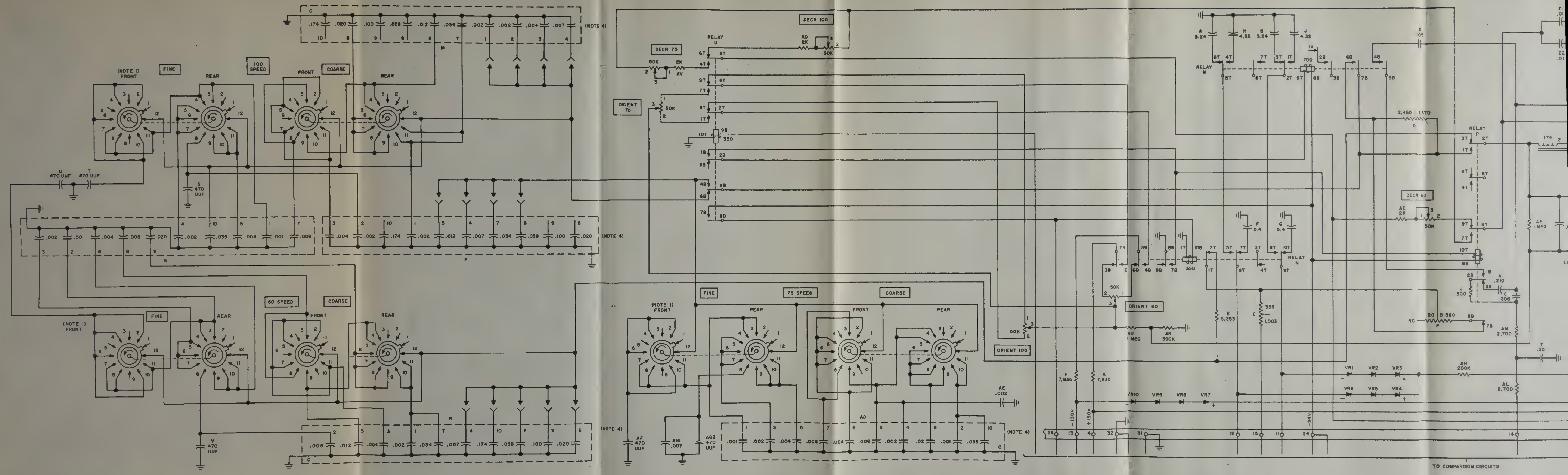


Figure 28.1. (Added) Distributor circuit, schematic diagram (TS-611C/FG only).

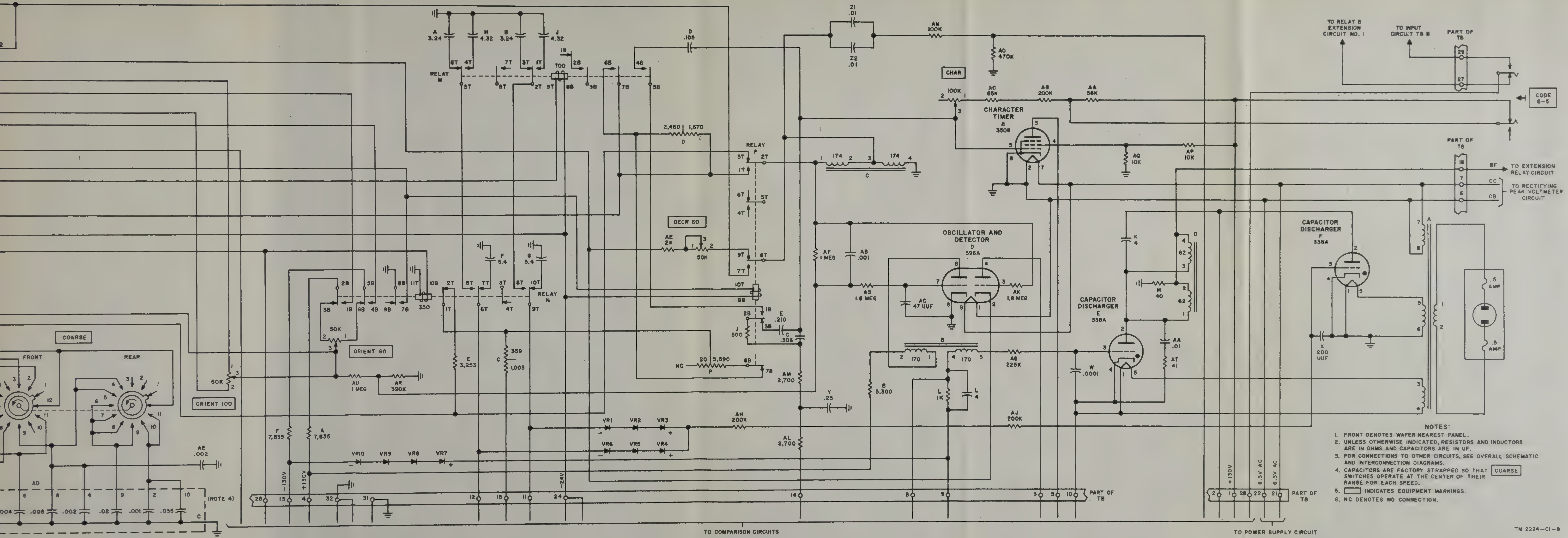
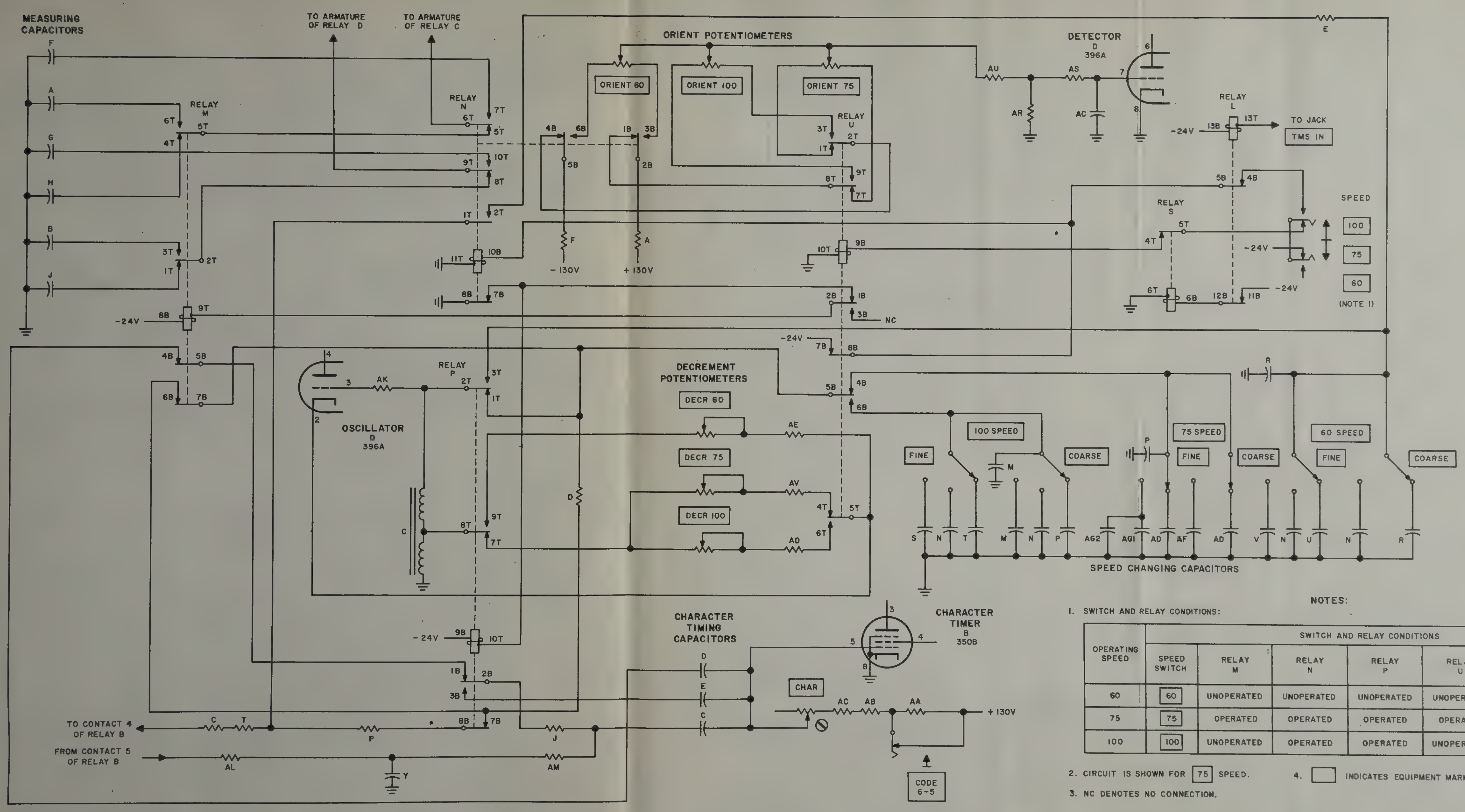


Figure 28.1. (Added) *Distributor circuit, schematic diagram (TS-611C/FG only).*



NOTES:

1. SWITCH AND RELAY CONDITIONS:

OPERATING SPEED	SWITCH AND RELAY CONDITIONS					
	SPEED SWITCH	RELAY M	RELAY N	RELAY P	RELAY U	REMARKS
60	60	UNOPERATED	UNOPERATED	UNOPERATED	UNOPERATED	RELAYS L AND S ARE HELD OPERATED BY JACK TMS IN
75	75	OPERATED	OPERATED	OPERATED	OPERATED	
100	100	UNOPERATED	OPERATED	OPERATED	UNOPERATED	

2. CIRCUIT IS SHOWN FOR 75 SPEED.
3. NC DENOTES NO CONNECTION.
4. ☐ INDICATES EQUIPMENT MARKINGS.

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Figure 29.1. (Added) *Speed-changing circuit, simplified schematic diagram (TS-611C/FG only).*

81.1. Circuit Elements Used for 60- or 66-Wpm Operation (TS–611C/FG Only)

(Added)

(figs. 26.1 and 29.1)

When the teletypewriter test set is arranged for 60- or 66-wpm operation, the 60–75–100 speed switch is set to the 60 position and relays M, N, P, and U are unoperated. Relay L is operated through the TMS IN jack (par. 74). Relay S operates through closed contacts 11B and 12B of operated relay L.

a. Capacitors F and G are used as measuring capacitors in the comparison circuit.

b. Variable resistor ORIENT 60 is used as the ORIENT potentiometer in the detector circuit.

c. Capacitors C and E are used to control the time delay in the character timer circuit.

d. Resistor DECR 60 is used as the DECR potentiometer in the pulse oscillator circuit.

e. Capacitors U, V, and sections of N and R, are used through the 60 SPEED-FINE and COARSE switches, to control the frequency of oscillation in the pulse oscillator circuit.

Paragraph 82, heading. After "Operation" add (TS–611A/FG only).

Add paragraph 82.1 after paragraph 82:

82.1. Circuit Elements Used for 75-Wpm Operation (TS–611C/FG Only)

(Added)

(figs. 26.1 and 29.1)

When the teletypewriter test set is arranged for 75-wpm operation, the 60–75–100 speed switch is set to the 75 position. Winding of relay L is energized through the TMS IN jack (par. 74). Relay S operates through closed contacts 11B and 12B of operated relay L. Relay U is operated because a circuit is completed from the —24-volt source, through the 60–75–100 speed switch, through closed contacts 5T and 4T of relay S, and through the winding of relay U to ground. Relay N operates through closed contacts 7B and 8B of relay U. Relay P operates through closed contacts 7B and 8B of relay N. Relay M operates through closed contacts 1B and 2B of relay U and through 7B and 8B of relay N.

a. Capacitors H and J are used as measuring capacitors in the comparison circuit.

b. Variable resistor ORIENT 75 is used as the ORIENT potentiometer in the detector circuit.

c. Capacitors C and D are used to control the time delay in the character timer circuit.

d. Resistor DECR 75 is used as the DECR potentiometer in the pulse oscillator circuit.

e. Capacitors AF, AG1, AG2, and sections of AD and P are used through the 75 SPEED-FINE and -COARSE switches to control the frequency of oscillation in the pulse oscillator circuit.

Paragraph 83, heading. After "Operation," add (TS–611A/FG only).

Add paragraph 83.1.

83.1. Circuit Elements Used for 100-Wpm Operation (TS–611C/FG Only)

(Added)

(figs. 26.1 and 29.1)

When the teletypewriter test set is arranged for 100-wpm operation, the 60–75–100 speed switch is operated to position 100. Relay L operates through the TMS IN jack (par. 74). Relay S operates through closed contacts 11B and 12B of operated relay L. Relay N operates because a circuit is completed from —24 volts through the 100-speed closed contacts of 60–75–100 speed switch, through closed contacts 4B and 5B of relay L, and through the winding of relay N to ground. Relay P operates because a circuit is completed from the —24-volt source through the winding of relay P, through closed contacts 7B and 8B of relay N to ground.

a. Capacitors A and B are used as measuring capacitors in the comparison circuit.

b. Variable resistor ORIENT 100 is used as the ORIENT potentiometer in the detector circuit.

c. Capacitor C is used to control the time delay in the character timer circuit.

d. Resistor DECR 100 is used as the DECR potentiometer in the pulse oscillator circuit.

e. Capacitors S, T, and sections of M, N, and P, are used through 100 SPEED-FINE and COARSE switches to control the frequency of oscillation in the pulse oscillator circuit.

Page 68, paragraph 84, line 5. Change (fig. 26) to (fig. 26 or 26.1).

Paragraph 85, heading. Change (fig. 30) to (fig. 30 or 30.1).

Paragraph 85*b*. Make the following changes:

Line 1. Add before "Winding": *(TS–611A/FG Only)*. Add subparagraph *b.1:*

b.1. (*TS–611C/FG Only*). (Added) Winding 5–7 of transformer B (fig. 73.1) is connected in series with winding 5–7 of transformer A in the power supply circuit to supply heater power to constant current supply tube E. Heater power for Wheatstone bridge tube C is obtained from

winding 7–8 of transformer A in the distributor circuit. Winding 11–13 of transformer B in the rectifying peak voltmeter circuit is the source of filament voltage for power rectifier tube D. Winding 8–10 of transformer B is the source of plate voltage for tube D.

Paragraph 86, heading. Change (fig. 30) to (fig. 30 or 30.1).

Add figure 29.1.

Page 69. Add figure 30.1.

Page 70, paragraph 87. Make the following changes:

Heading. Change (fig. 30) to (fig. 30 or 30.1).

Under the heading, add the following note:

Note. The circuit description in this paragraph is applicable to the TS–611C/FG when diodes VR11 and VR12 are substituted for tubes V301 and V302 (used in the TS–611A/FG), respectively.

Page 71, paragraph 89. Add subparagraph *e.*

e. (*TS–611C/FG Only*) (Added). Heater power for constant current supply tube E is obtained from winding 5–7 of transformer A in series with winding 5–7 of transformer B (par. 85*b*.1). Heater power for reference voltage tube F is obtained from winding 7–8 of transformer A in the distributor circuit.

Page 74, paragraph 94, heading. Change (figs. 32 and 33) to (figs. 32 and 33 or 33.1).

Page 75, paragraph 95. Make the following changes:

In subparagraph *a*, line 1, add before "The": (*TS–611A/FG Only*).

Add subparagraph *a.1:*

a.1. (*TS–611C/FG Only*) (Added). Controls and meters are the same as listed in *a* above except that the SPD–75/100 switch is replaced by the 60–75–100 speed switch.

In subparagraph *b*, line 1, add before "The": (*TS–611A/FG Only*).

Add subparagraph *b.1:*

b.1. (*TS–611C/FG Only*) (Added). The 60–75–100 speed switch is used to adjust the teletypewriter test set for use at speeds of 60, 75, or 100 wpm. The bottom inner contact (fig. 33.1) of the switch is connected to negative battery. The switch provides for three speeds of operation as given in (1) through (3) below. Operation of the 60–75–100 speed switch sets up the correct relay sequence to connect the proper measuring capacitors in the speed-changing circuit (pars. 81.1, 82.1, and 83.1).

(1) *75 wpm.* When the switch is set to 75, negative battery is supplied through the closed contacts of the switch, through operated contacts 3B and 4B of respective extension circuit relay C, through the winding of relay U and to ground (par. 82.1).

(2) *60 wpm.* When the switch is set to 60, the battery circuit is open (par. 81.1).

(3) *100 wpm.* When the switch is set to the 100, negative battery is supplied through the closed contacts of the switch, through operated contacts 4B and 5B of respective extension circuit relay A, through the winding of relay N to ground (par. 83.1).

Subparagraph *d*, line 3. Change (fig. 33) to (fig. 33 or 33.1).

Page 76, figure 32. Make the following changes:

Change the word NOTE to NOTES.

Designate the existing note 1.

Add note 2 after note 1.

2. A MAXIMUM OF SEVEN EXTENSION UNITS MAY BE USED IN THE TS–611C/FG.

Add figure 33.1.

Page 77, paragraph 95*e*. Make the following changes:

Line 3. Change (fig. 33) to (fig. 33 or 33.1).

Subparagraph *e*(1), line 3. Change (fig. 33) to (fig. 33 or 33.1).

Subparagraph *e*(2), line 3. Change (fig. 33) to (fig. 33 or 33.1).

Paragraph 97, heading. After "Lamp" add (TS–611A/FG Only). Add paragraph 97.1.

97.1. BSY Lamp (TS–611C/FG Only)

(Added)

(fig. 73.1)

In this paragraph, explanations of the BSY lamp supervisory circuits are based on the assumption that optional ground-interrupter relay equipment is connected to the teletypewriter test set as described in paragraph 22.

a. General.

(1) When a signal input plug is inserted into the TMS IN jack of any extension unit and the associated READ switch is operated, the BSY lamp will light continuously at all other stations to indicate that the teletypewriter test set is being used.

(2) When the CODE 6–5 switch is set to the 6 position and a signal input plug is inserted into the TMS IN jack at the

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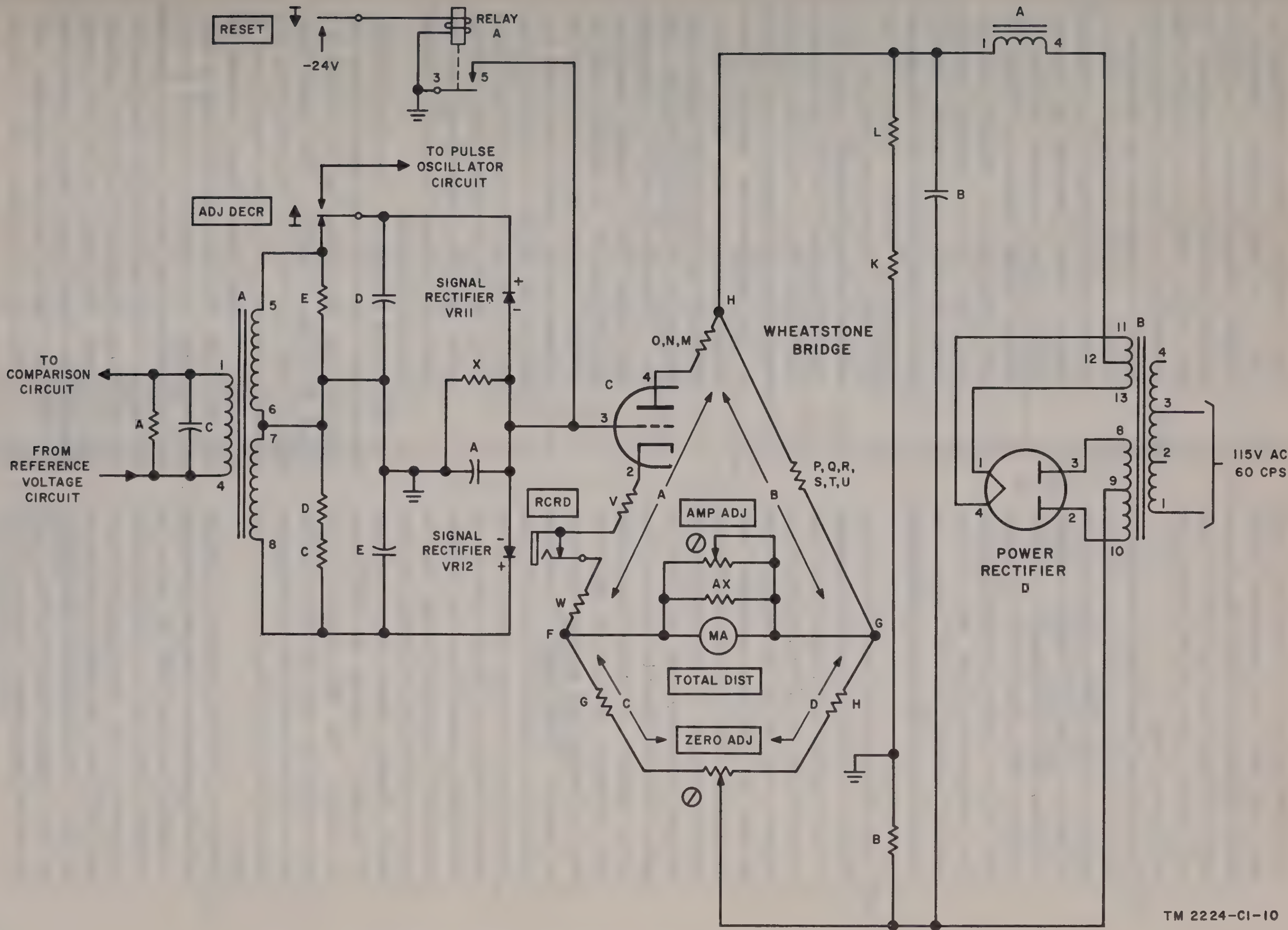


Figure 30.1. (Added) *Rectifying peak voltmeter circuit, simplified schematic diagram (TS–611C/FG only).*

teletypewriter test set, or at any extension unit with the associated READ switch operated, the BSY lamp associated with the operated TMS IN jack will flash at a rate of 120 interruptions per minute (ipm).

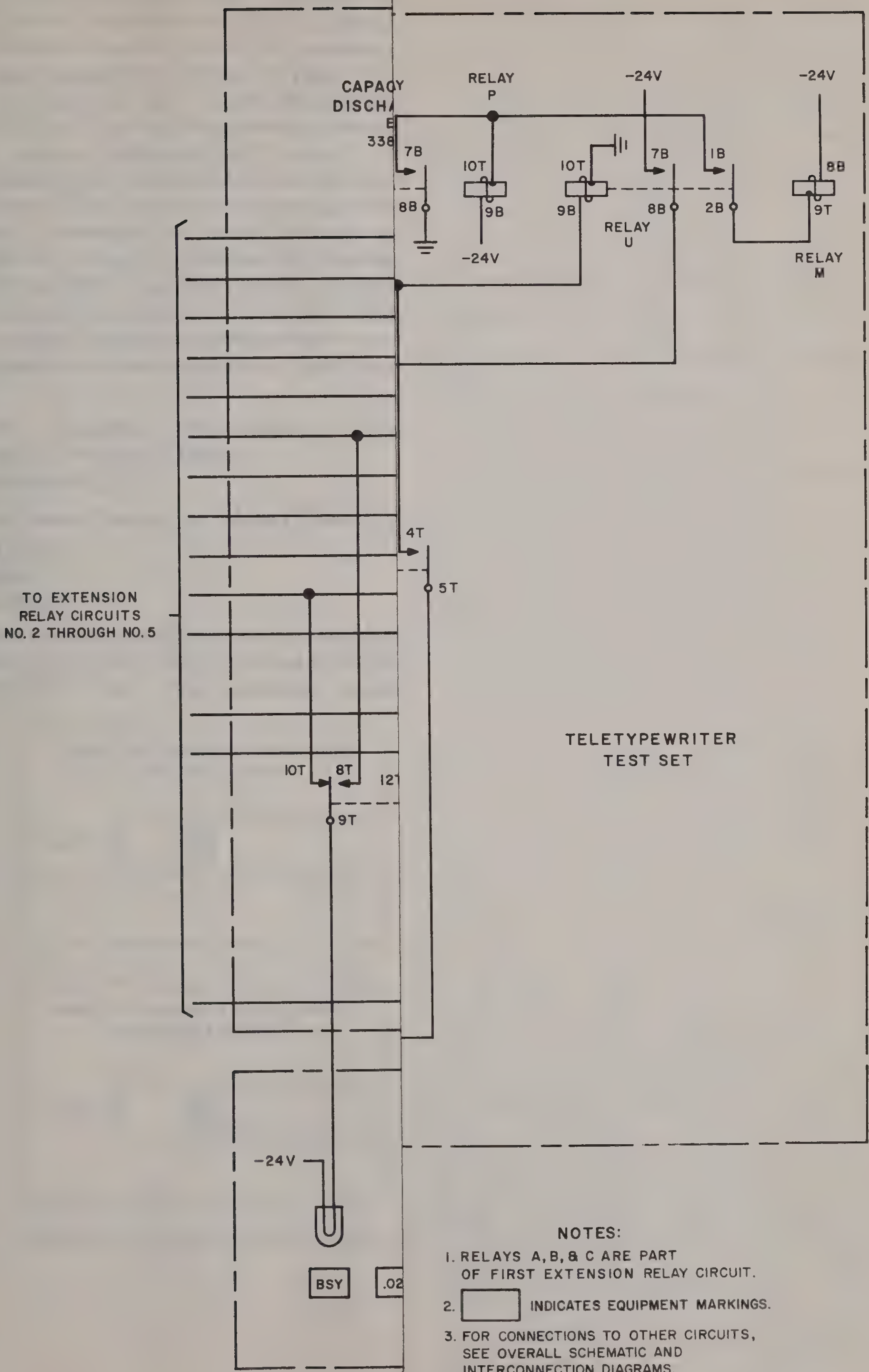
(3) When a signal input plug is inserted into the TMS IN jack at the teletypewriter test set and the CODE 6–5 switch is set to position 6, the BSY lamp at the teletypewriter test set will flash at a rate of 120 ipm. When the CODE 6–5 switch is set to the 5 position, the BSY lamp at the teletypewriter test set will not operate; however, the BSY lamps at all extension units will operate continuously ((1) above).

b. BSY Lamp Flashing 120 Times Each Minute.

(1) When the CODE 6–5 switch is operated to the 6 position and a signal input plug is inserted into the TMS IN jack at any extension unit or at the teletypewriter test set, the BSY lamp associated with the operated TMS IN jack will flash at a rate of 120 ipm. If it is assumed that the plug is inserted into the TMS IN jack of the teletypewriter test set, relay L will operate. A circuit is completed from battery at contacts 8B and 9B of relay L, through the winding of relay R to ground. When relay R operates, ground from contacts 1T and 2T complete a circuit for the operation of an external 60-ipm and 120-ipm interrupter. Interrupted ground from the 120-ipm interrupter is connected through the contacts of the CODE 6–5 switch (in position 6), through closed contacts 9T and 8T of relay L, through the BSY lamp, to battery. The BSY lamp will now flash to indicate that the teletypewriter test set is calibrated for six intelligence elements for each teletypewriter character.

(2) When the CODE 6–5 switch is operated to the 6 position and a signal input plug is inserted into the TMS IN jack at an extension unit, and the READ switch is operated, the associated extension unit BSY lamp will flash at a rate of 120 ipm. This indicates to the operator at the extension unit that the teletypewriter test circuit is set up for 6 code operation. Assume extension unit No. 1 is being utilized. Battery is applied through terminal 25 of TB B, through normally-closed contacts 9B and 10B of relay A in extension relay circuits No. 5, 4, 3, and 2, to the winding of relay A of extension relay circuit No. 1. Ground for the winding of relay A, extension relay circuit No. 1, is obtained through closed contacts of operated READ switch (extension unit No. 1), through closed contacts of TMS IN jack (plug inserted, extension unit circuit No. 1), and through normally closed contacts of unoperated TMS IN jack on teletypewriter test set to ground (terminal 32 TB B). Battery for the BSY lamp on extension unit No. 1 is obtained through terminal 16 on TB A, through terminal 11 of TB 1 in extension relay circuit No. 1, and to the —24-volt supply through terminal 25 of TB B on the teletypewriter test set. Interrupted ground for the BSY lamp of extension unit No. 1 is obtained through terminal 15 of TB A in extension unit No. 1, to terminal 2 of TB 1 in extension relay circuit No. 1, through closed contacts 9T and 8T of operated relay A, through terminal 28 of TB in the distributor circuit, through the closed contacts of the CODE 6–5 switch (in position 6), through terminals 29 of TB and TB B in the distributor and teletypewriter test set, respectively, and to interrupted ground through the external optional equipment.

c. BSY Lamp Flashing 60 Times Each Minute. Assume that a circuit is being tested at the teletypewriter test set position and the CODE 6–5 switch is in the 5 position. The signal input plug, inserted into the TMS IN jack at the teletypewriter test set, will cause relays L and K to operate. Ground from closed contacts 4B and 5B of relay K causes the BSY lamp to light at all extension units; however, the BSY lamp at the teletypewriter test set will not light because the test is being made at the teletypewriter test set and open contacts 9T and 10T of operated relay L break the circuit for the BSY lamp. Assume that a signal input plug is inserted into the TMS IN jack of the first extension unit. Relay A (extension relay circuit No. 1) cannot



NOTES:

1. RELAYS A, B, & C ARE PART OF FIRST EXTENSION RELAY CIRCUIT.
2. ▭ INDICATES EQUIPMENT MARKINGS.
3. FOR CONNECTIONS TO OTHER CIRCUITS, SEE OVERALL SCHEMATIC AND INTERCONNECTION DIAGRAMS.

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teletypewriter test set, or at any extension unit with the associated READ switch operated, the BSY lamp associated with the operated TMS IN jack will flash at a rate of 120 interruptions per minute (ipm).

(3) When a signal input plug is inserted into the TMS IN jack at the teletypewriter test set and the CODE 6–5 switch is set to position 6, the BSY lamp at the teletypewriter test set will flash at a rate of 120 ipm. When the CODE 6–5 switch is set to the 5 position, the BSY lamp at the teletypewriter test set will not operate; however, the BSY lamps at all extension units will operate continuously ((1) above).

b. BSY Lamp Flashing 120 Times Each Minute.

(1) When the CODE 6–5 switch is operated to the 6 position and a signal input plug is inserted into the TMS IN jack at any extension unit or at the teletypewriter test set, the BSY lamp associated with the operated TMS IN jack will flash at a rate of 120 ipm. If it is assumed that the plug is inserted into the TMS IN jack of the teletypewriter test set, relay L will operate. A circuit is completed from battery at contacts 8B and 9B of relay L, through the winding of relay R to ground. When relay R operates, ground from contacts 1T and 2T complete a circuit for the operation of an external 60-ipm and 120-ipm interrupter. Interrupted ground from the 120-ipm interrupter is connected through the contacts of the CODE 6–5 switch (in position 6), through closed contacts 9T and 8T of relay L, through the BSY lamp, to battery. The BSY lamp will now flash to indicate that the teletypewriter test set is calibrated for six intelligence elements for each teletypewriter character.

(2) When the CODE 6–5 switch is operated to the 6 position and a signal input plug is inserted into the TMS IN jack at an extension unit, and the READ switch is operated, the associated extension unit BSY lamp will flash at a rate of 120 ipm. This indicates to the operator at the extension unit that the teletypewriter test circuit is set up for 6 code operation. Assume extension unit No. 1 is being utilized. Battery is applied through terminal 25 of TB B, through normally-closed contacts 9B and 10B of relay A in extension relay circuits No. 5, 4, 3, and 2, to the winding of relay A of extension relay circuit No. 1. Ground for the winding of relay A, extension relay circuit No. 1, is obtained through closed contacts of operated READ switch (extension unit No. 1), through closed contacts of TMS IN jack (plug inserted, extension unit circuit No. 1), and through normally closed contacts of unoperated TMS IN jack on teletypewriter test set to ground (terminal 32 TB B). Battery for the BSY lamp on extension unit No. 1 is obtained through terminal 16 on TB A, through terminal 11 of TB 1 in extension relay circuit No. 1, and to the —24-volt supply through terminal 25 of TB B on the teletypewriter test set. Interrupted ground for the BSY lamp of extension unit No. 1 is obtained through terminal 15 of TB A in extension unit No. 1, to terminal 2 of TB 1 in extension relay circuit No. 1, through closed contacts 9T and 8T of operated relay A, through terminal 28 of TB in the distributor circuit, through the closed contacts of the CODE 6–5 switch (in position 6), through terminals 29 of TB and TB B in the distributor and teletypewriter test set, respectively, and to interrupted ground through the external optional equipment.

c. BSY Lamp Flashing 60 Times Each Minute. Assume that a circuit is being tested at the teletypewriter test set position and the CODE 6–5 switch is in the 5 position. The signal input plug, inserted into the TMS IN jack at the teletypewriter test set, will cause relays L and K to operate. Ground from closed contacts 4B and 5B of relay K causes the BSY lamp to light at all extension units; however, the BSY lamp at the teletypewriter test set will not light because the test is being made at the teletypewriter test set and open contacts 9T and 10T of operated relay L break the circuit for the BSY lamp. Assume that a signal input plug is inserted into the TMS IN jack of the first extension unit. Relay A (extension relay circuit No. 1) cannot

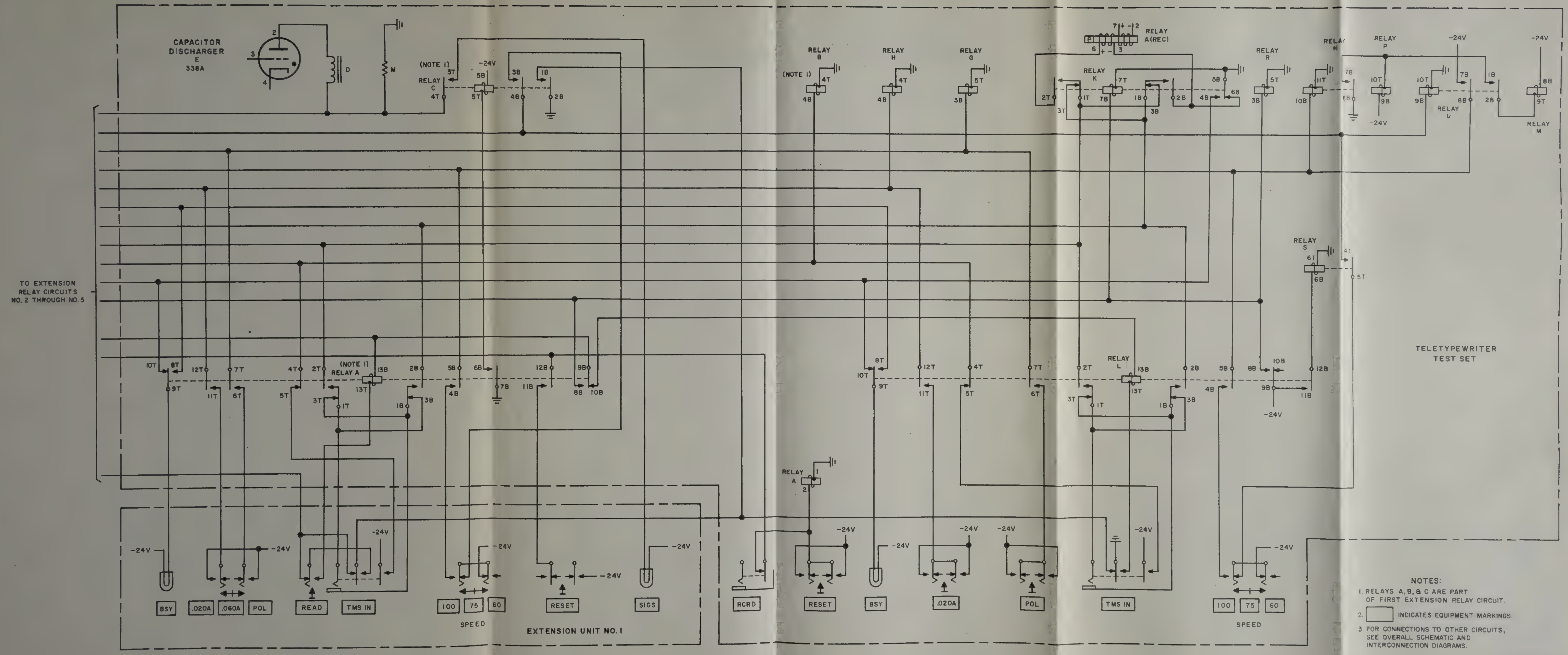

Figure 33.1.(Added) Extension unit circuit, simplified schematic diagram (TS-611C/FG only).

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operate because of the lockout feature (par. 94). A circuit is completed from battery, through the TMS IN jack at extension unit No. 1, through normally closed contacts 5T and 4T of unoperated relay A, and through the winding of relay B to ground. Ground from the 1T and 2T contacts of operated relay R in the teletypewriter test set starts the 60-ipm interrupter (*b*(1) above). A 60-ipm ground signal is connected through contacts 1T and 2T of relay B in extension relay circuit No. 1, through the closed contacts of the CODE 6-5 switch (in position 5), through contacts 8T and 9T of operated relay L, the BSY lamp in teletypewriter test set. The BSY lamp flashes at a rate of 60 ipm to indicate that use of the teletypewriter test set is required at an extension unit.

Page 85. Paragraph 106, heading. After "Volts" add (TS-611A/FG Only).

Add paragraph 106.1.

106.1. Dc Power Supply, 24 Volts (TS-611C/FG Only)

(added)

(fig. 38.1)

Operation of the 24-volt power supply, supplied as a part of the TS-611C/FG, is the same as for the TS-611A/FG (par. 106). However, minor circuit changes have been made in the TS-611C/FG (*a–c* below).

a. Equivalents of resistor R601, capacitor C602, and terminal board TB601 are not used.

b. The value of the fuse has been changed to 1¼ amperes and the fuse is designated "J".

c. Other designation changes are shown on figure 38.1. Add figure 38.1.

Page 87, paragraph 110. Make the following changes:

Subparagraph *a*, line 7. Change (fig. 30) to (fig. 30 or 30.1).

Subparagraph *b*, line 10 from end of paragraph. Change (fig. 30) to (fig. 30 or 30.1).

Page 89, paragraph 110*c*. Make the following changes:

Line 1. Change (figs. 30 and 31) to (figs. 30 or 30.1 and 31).

Line 13, at end of sentence. Add (On the TS-611C/FG models, tubes V301 and V302 are replaced by diodes VR11 and VR12, respectively).

Paragraph 111. Make the following changes:

Heading. Change (figs. 26, 30, and 31) to (figs. 26 or 26.1, 30 or 30.1, and 31).

Subparagraph *a*, line 2. Change (figs. 26 and 31) to (figs. 26 or 26.1 and 31).

Subparagraph *c*. Delete the last sentence and substitute:

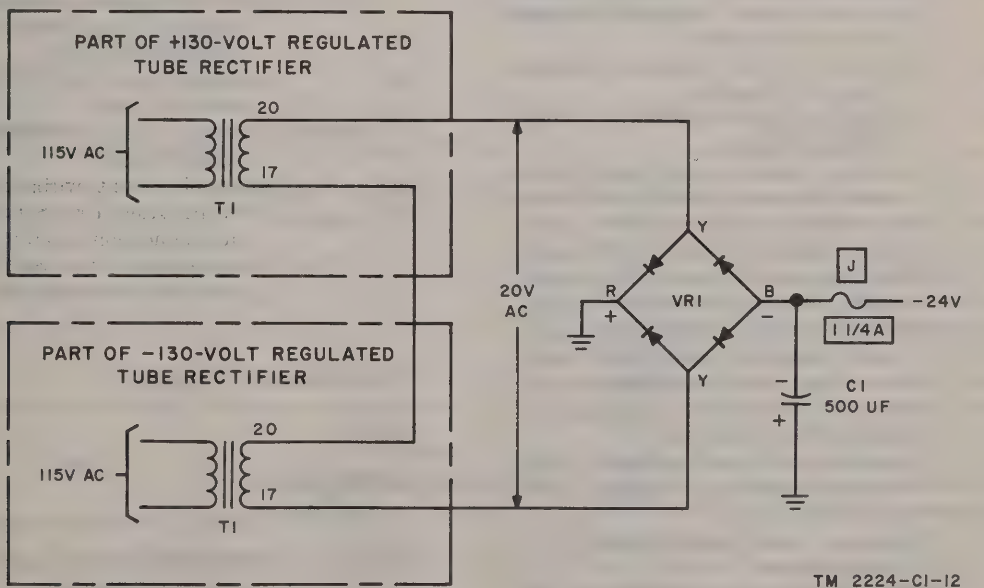


Figure 38.1. (Added) *24-volt dc power supply simplified, schematic diagram (TS-611C/FG only).*

In the TS–611A/FG only, the procedure is repeated for the speed of either 75 or 100 wpm using the DECR 75–100 potentiometer. In the TS–611C/FG only, the procedure is repeated for speeds of both 75 and 100, using the DECR 75 and DECR 100 potentiometers, respectively.

Page 93, paragraph 113, heading. Change: (figs. 26 and 40) to (figs. 26 or 26.1, and 40).

Page 94, chapter 6, heading. Make the following changes:

Change the word *Note* to *Notes*.

Designate the existing note 1.

Add after note 1:

2. Component reference designations throughout this chapter are to the TS–611A/FG, unless otherwise indicated. Refer to the cross-reference designations (par. 56.1) when performing field maintenance on the TS–611C/FG.

Page 95, paragraph 115 *a* through *d*.

a. Schematic Diagrams (Superseded).

Figure No. TS–611A/FG	Figure No. TS–611C/FG	Title
25		Input circuit and measuring circuit, schematic diagram (TS–611A/FG only).
	25. 1	Input circuit and measuring circuit, schematic diagram (TS–611C/FG only).
28		Distributor circuit, schematic diagram (TS–611A/FG only).
	28. 1	Distributor circuit, schematic diagram (TS–611C/FG only).
39	39	115-volt ac power distribution circuit, schematic diagram.
68		24-volt dc power supply circuit, schematic diagram (TS–611A/FG only).
	68. 1	24-volt dc power supply circuit, schematic diagram (TS–611C/FG only).
69		Rectifying peak voltmeter circuit, schematic diagram (TS–611A/FG only).
	69. 1	Rectifying peak voltmeter circuit, schematic diagram (TS–611C/FG only).
70	70	Power supply circuit, schematic diagram.
71		Extension unit circuit, schematic diagram (TS–611A/FG only).
	71. 1	Extension unit and extension relay circuits, schematic diagram (TS–611C/FG only).
72	72	Regulated tube rectifier circuit, schematic diagram.
73		Teletypewriter Test Set TS–611A/FG, overall schematic diagram.
	73. 1	Teletypewriter Test Set TS–611C/FG, overall schematic diagram.

b. Wiring Diagrams.

Figure No. TS–611A/FG	Figure No. TS–611C/FG	Title
57	57	REG TUBE RECT+TG panel, wiring diagram.
58	58	REG TUBE RECT−TG panel, wiring diagram.
59		COMP CKT panel, wiring diagram (TS–611A/FG only).
	59. 1	COMP CKT panel, wiring diagram (TS–611C/FG only).
60		RECT PEAK VM panel, wiring diagram (TS–611A/FG only).
	60. 1	RECT PEAK VM panel, wiring diagram (TS–611C/FG only).
61		DISTRIBUTOR panel, wiring diagram (TS–611A/FG only).
	61. 1	DISTRIBUTOR panel, wiring diagram (TS–611C/FG only).
62		PWR SUP panel, wiring diagram (TS–611A/FG only).
	62. 1	PWR SUP panel, wiring diagram (TS–611C/FG only).
63		24 VOLT SUP panel, wiring diagram (TS–611A/FG only).
	63. 1	24 VOLT SUP panel, wiring diagram (TS–611C/FG only).
64		EXT CKT panels, wiring diagram for extension relay circuits 1 through 15 (TS–611A/FG only).
	64. 1	EXT CKT panels, wiring diagram for 7 extension relay circuits 1 through 7 (TS–611C/FG only).
65		Extension unit, wiring diagram (TS–611A/FG only).
	65. 1	Extension unit, wiring diagram (TS–611C/FG only).
66	66	Ac supply circuit, wiring diagram.
67		Teletypewriter Test Set TS–611A/FG, interconnection diagram.
	67. 1	Teletypewriter Test Set TS–611C/FG, interconnection diagram.

c. Part Location Diagrams.

Figure No. TS–611A/FG	Figure No. TS–611C/FG	Title
45	45	REG TUBE RECT panel, front view with cover removed.
46	46	REG TUBE RECT panel, rear view.
47	47	COMP CKT panel, front view.
48		RECT PEAK VM panel, rear view with radiation shield removed (TS–611A/FG only).

Figure No.		Title
TS-611A/FG	TS-611C/FG	
	48. 1	RECT PEAK VM panel, rear view, radiation shield removed (TS-611C/FG only).
49		DISTRIBUTOR panel, rear view (TS-611A/FG only).
	49. 1	DISTRIBUTOR panel, rear view (TS-611C/FG only).
50		DISTRIBUTOR panel, terminal (TS-611A/FG only).
	50. 1	DISTRIBUTOR panel, mounting boards (TS-611C/FG only).
51	51	PWR SUP panel, rear view.
52		24 VOLT SUP panel, rear view (TS-611A/FG only).
	52. 1	24 VOLT SUP panel, front and rear views (TS-611C/FG only).
53		EXT CKT panels, rear view (TS-611A/FG only).
	53. 1	EXT CKT panels, front and rear views (TS-611C/FG only).
54	54	Relay spring combinations.
55	55	MIL-STD resistor codes.
56	56	MIL-STD capacitor codes.

d. Voltage and Resistance Diagrams.

Figure No.		Title
TS-611A/FG	TS-611C/FG	
43		Voltage and resistance values for distributor and rectifying peak voltmeter circuits (TS-611A/FG only).
	43. 1	Voltage and resistance values for distributor and rectifying peak voltmeter circuits (TS-611C/FG only).
44		Voltage and resistance values for power supply circuits (TS-611A/FG only).
	44. 1	Voltage and resistance values for power supply circuits (TS-611C/FG only).

Page 96, paragraph 118, last line. Change (fig. 73) to (fig. 73 or 73.1).

Page 97, chart, symptom 2. In the "Corrective action" column, last sentence, change "fig. 25" to fig. 25 or 25.1. . . .

Page 98, chart. Make the following changes:

In the "Corrective action" column, for symptom 2, change lines 2 and 3 of subparagraph (3) to terminals 7 and 8 of terminal board B in the TS-611A/FG or terminals 1 and 3 of terminal board B in the TS-611C/FG.

In the "Symptom" Column, symptom 3. After "Failure of 24-volt dc supply," add (TS-611A/FG only).

Add symptom 3.1

Symptom	Probable trouble	Corrective action
3.1. Failure of 24-volt dc supply (TS-611C/FG only).	*a.* Improper ac input to 24-volt supply.	*a.* If dc voltage measured across terminals 32 (grd) and 24 (−24v) of terminal board TB in distributor does not measure −24 volts ±2 volts, check ac input across terminals Y of rectifier VR1 on 24-volt power supply. This should be 22 volts ac ±2 volts. If this voltage is not present, check circuit to transformer T1 of 130-volt power supplies. Trouble can be caused if windings of the two transformers T1 are not properly connected in series. Check for defect and correct (fig. 68.1, par. 106 and 107).
	b. Aged or defective rectifiers in VR1 unit.	*b.* If proper dc voltage cannot be obtained, the rectifier unit could be aged or defective and should be replaced.
	c. Shorted capacitor C1------	*c.* Check continuity across C1 with the circuit de-energized. If capacitor is defective, replace.

Page 99, chart, "Corrective action" column. Make the following changes:

Symptom 4*c*, line 3. Change (fig. 44) to (fig. 44 or 44.1).

Symptom 7*b*, lines 4 and 5. Change (fig. 43) to (fig. 43 or 43.1).

Symptom 8*a*, line 9. Change (fig. 43) to (fig. 43 or 43.1).

Page 100, chart. Make the following changes:

After Symptom 9, Symptom column, add the following note:

Note. All references to tubes V301 and V302 in symptoms 10, 12, and 13 below apply to the TS–611A/FG only; for the TS–611C/FG, substitute diodes VR11 and VR12, respectively.

Symptom 10, Corrective action column, subparagraph *b*, line 2. Change (fig. 43) to (fig. 43 or 43.1).

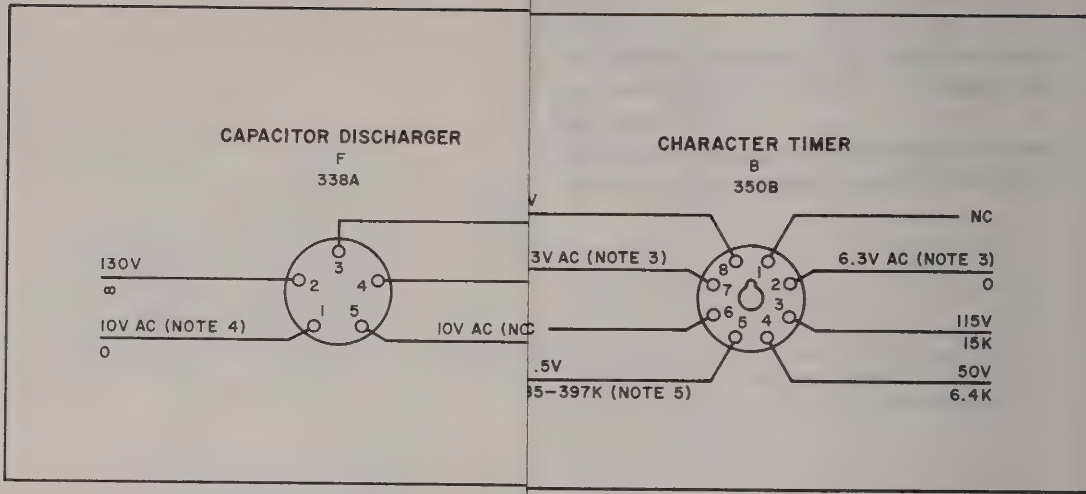
Page 102, chart, symptom 15, Corrective action column, subparagraph (2) line 3. Change (fig. 43) to (fig. 43 or 43.1).

Page 103, chart, symptom 19, Symptom column, line 2. After "not at another" add (TS–611A/FG only).

Page 104, chart. Make the following changes:

Add symptom 19.1.

Symptom	Probable trouble	Corrective action
19.1 Proper functioning at one speed but not at another (TS–611C/FG only).		
a. Operates at 60 wpm but not at 100 wpm.	(1) Relay N or P defective or 60–75–100 speed switch defective.	(1) Check relay N winding and 60–75–100 speed switch if relay fails to operate. If relay N operates and relay P is inoperative, check continuity of winding on relay P. Check for defective contacts on relay P. Repair or replace as required.
	(2) DECR 100 potentiometer or associated circuit defective.	(2) If no control is apparent with variation of DECR 100 potentiometer, check associated circuit for defective component and repair or replace as required.
	(3) ORIENT 100 potentiometer or associated circuit defective.	(3) If BIAS meter indication for orientation position of the calibration cannot be adjusted by varying the ORIENT 100 potentiometer, check ORIENT 100 potentiometer and its associated circuit for defective component or circuit and replace or repair as required.
b. Operates at 60 wpm but not at 75 wpm.	(1) Relays U or M defective (if operates at 100 wpm).	(1) Check relays U and M winding and contacts. Make corrective repairs as required.
	(2) DECR 75 potentiometer or associated circuit defective.	(2) Same as *a*(2) above except on 75 speed circuit.
	(3) ORIENT 75 potentiometer or associated circuit defective.	(3) Same as *a*(3) above except on ORIENT 75 potentiometer circuit.
c. Operates at 75 wpm and 100 wpm but not at 60 wpm.	(1) DECR 60 potentiometer or associated circuit defective.	(1) Same as in *a*(2) above except on 60 speed circuit.
	(2) ORIENT 60 potentiometer or associated circuit defective.	(2) Same as in *a*(3) above except on 60 speed circuit.



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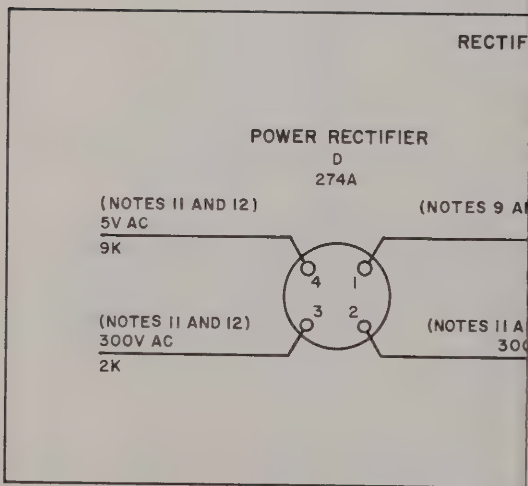

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Symptom 23, Symptom column, last line. After "in erroneous meter indications" add (TS–611A/FG only).

Add Symptom 23.1.

Symptom	Probable trouble	Corrective action
23.1. Changing speed at an extension unit results in erroneous meter indications (TS–611C/FG only).	(1) If erroneous readings are obtained from operation at one extension unit but not the others, the 60–75–100 switch or the associated A relay could be defective. (2) If erroneous readings are obtained from operation at any extension unit, speed changing relays or associated circuits are defective.	(1) Check contacts of the 60–75–100 speed switch at the extension unit and the associated relay A at teletypewriter test set. (2) Refer to 19.1 above for corrective action required.

Page 105, chart. Make the following changes:

Symptom 24, Symptom column, last line. After "and 6-code operation" add (TS–611A/FG only).

Add symptom 24.1.

Symptom	Probable trouble	Corrective action
24.1. BSY lamp does not flash at 120 ipm when the measuring of a signal at an extension unit is attempted with the teletypewriter test set at 6-code operation (CODE 6–5 switch in position 6).	*a.* If trouble occurs at only one extension unit, defective BSY lamp, or defective contacts 9T to 8T on 9B to 8B on associated relay A. *b.* If trouble occurs at all extension units, defective relay R, CODE 6–5 switch, or optional interrupted ground equipment. *c.* Open circuit in series loop cabling from extension units to teletypewriter test set.	*a.* Replace BSY lamp if defective. Clean and adjust defective contacts on relay. *b.* Check for operation of relay R; then check the contacts associated with position 6 on CODE 6–5 switch. Temporarily strap terminal 29 on TB B to ground and check to see that the BSY lamp operates in order to check the interrupted ground circuit. *c.* If symptom occurs at all extension units, the trouble is in the common circuit in the teletypewriter test set. Check and repair or replace defective circuit or components.

Page 106, paragraph 119. Add to heading: (TS–611A/FG Only).

Paragraph 120*c*(1). Make the following changes:

Add to heading (TS–611A/FG only).

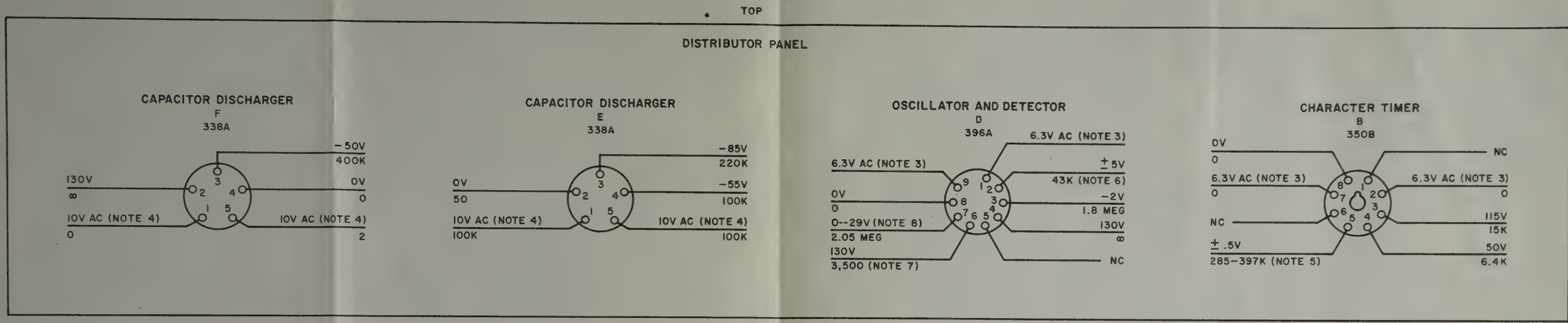
Add after subparagraph *c*(1).

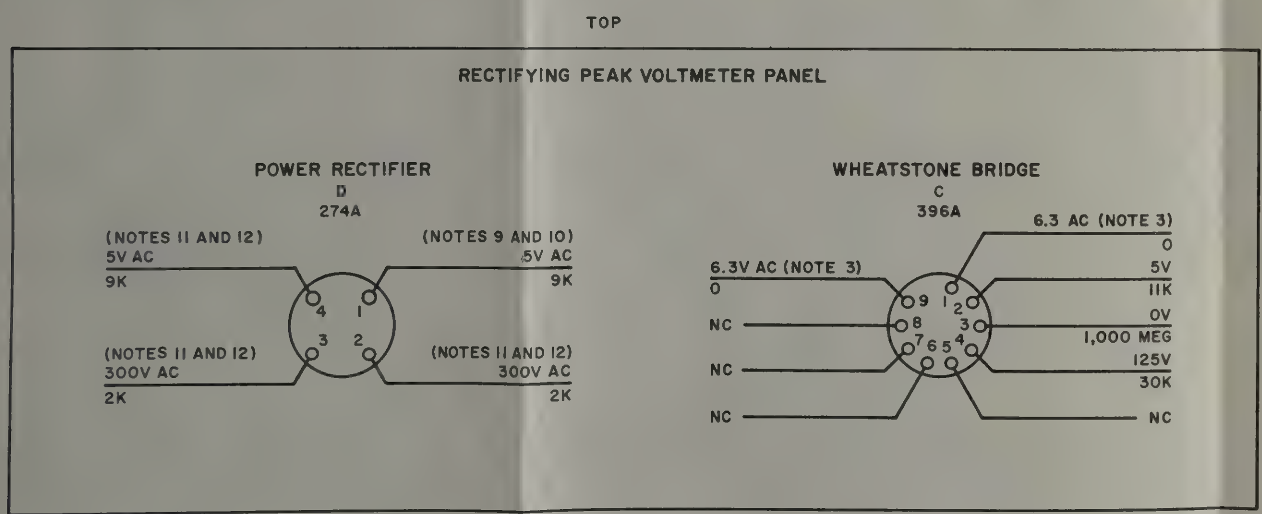
(1.1) *Filament voltages* (*TS–611C/FG only*). The filament voltages for the tubes in each subcircuit of the teletypewriter test set are usually obtained from the transformers which are part of that subcircuit. For example, the filament voltage for the tubes in the regulated tube rectifier is obtained from transformer T1. Exceptions to this arrangement are as given in (*a*) and (*b*) below.

(*a*) Filament voltage for tube C in the rectifying peak voltmeter circuit and tube F in the power supply circuit is obtained from transformer A in the distributor circuit.

(*b*) Filament voltages for tube E in the power supply circuit are obtained from windings 5 and 7 of transformer A within the power supply circuit connected in series with windings 5 and 7 of transformer B in the rectifying peak voltmeter circuit.

Add figure 43.1.





NOTES:

1. VOLTAGES MEASURED TO GROUND, UNLESS OTHERWISE INDICATED, WITH A 1,000 OHMS–PER–VOLT METER.
2. ALL RESISTANCE MEASUREMENTS MADE WITH THE POWER OFF AND FILTER CAPACITORS DISCHARGED.
3. MEASURED BETWEEN TERMINALS 1 AND 9 FOR C AND, 2 AND 7 FOR B.
4. MEASURED BETWEEN TERMINALS 1 AND 5.
5. RESISTANCE DEPENDS ON POSITION OF CHAR POTENTIOMETER
6. RESISTANCE DEPENDS ON POSITION OF DECR 60 POTENTIOMETER.
7. LUG 4 OF TB GROUNDED WITH CLIP.
8. VOLTAGE DEPENDS ON POSITION OF ORIENT 60 POTENTIOMETER.
9. MEASURED BETWEEN TERMINALS 1 AND 4.
10. MEASURED TO GROUND +200 VOLTS.
11. MEASURE TO TERMINAL 9 OF TRANSFORMER B.
12. MEASURED TO GROUND −50 VOLTS.
13. ALL VOLTAGES DC UNLESS OTHERWISE INDICATED.
14. ALL RESISTANCES IN OHMS UNLESS OTHERWISE INDICATED.
15. ALL VOLTAGES POSITIVE UNLESS OTHERWISE INDICATED.

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Figure 43.1. (Added) *Voltage and resistance values for distributor and rectifying peak voltmeter circuits (TS–611C/FG only).*

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Symptom 23, Symptom column, last line. After "in erroneous meter indications" add (TS–611A/FG only).
Add Symptom 23.1.

Symptom	Probable trouble	Corrective action
23.1. Changing speed at an extension unit results in erroneous meter indications (TS–611C/FG only).	(1) If erroneous readings are obtained from operation at one extension unit but not the others, the 60–75–100 switch or the associated A relay could be defective. (2) If erroneous readings are obtained from operation at any extension unit, speed changing relays or associated circuits are defective.	(1) Check contacts of the 60–75–100 speed switch at the extension unit and the associated relay A at teletypewriter test set. (2) Refer to 19.1 above for corrective action required.

Page 105, chart. Make the following changes:

Symptom 24, Symptom column, last line. After "and 6-code operation" add (TS–611A/FG only).

Add symptom 24.1.

Symptom	Probable trouble	Corrective action
24.1. BSY lamp does not flash at 120 ipm when the measuring of a signal at an extension unit is attempted with the teletypewriter test set at 6-code operation (CODE 6–5 switch in position 6).	*a.* If trouble occurs at only one extension unit, defective BSY lamp, or defective contacts 9T to 8T on 9B to 8B on associated relay A. *b.* If trouble occurs at all extension units, defective relay R, CODE 6–5 switch, or optional interrupted ground equipment. *c.* Open circuit in series loop cabling from extension units to teletypewriter test set.	*a.* Replace BSY lamp if defective. Clean and adjust defective contacts on relay. *b.* Check for operation of relay R; then check the contacts associated with position 6 on CODE 6–5 switch. Temporarily strap terminal 29 on TB B to ground and check to see that the BSY lamp operates in order to check the interrupted ground circuit. *c.* If symptom occurs at all extension units, the trouble is in the common circuit in the teletypewriter test set. Check and repair or replace defective circuit or components.

Page 106, paragraph 119. Add to heading: (TS–611A/FG Only).

Paragraph 120*c*(1). Make the following changes:

Add to heading (TS–611A/FG only).

Add after subparagraph *c*(1).

(1.1) *Filament voltages (TS–611C/FG only).* The filament voltages for the tubes in each subcircuit of the teletypewriter test set are usually obtained from the transformers which are part of that subcircuit. For example, the filament voltage for the tubes in the regulated tube rectifier is obtained from transformer T1. Exceptions to this arrangement are as given in (*a*) and (*b*) below.

(*a*) Filament voltage for tube C in the rectifying peak voltmeter circuit and tube F in the power supply circuit is obtained from transformer A in the distributor circuit.

(*b*) Filament voltages for tube E in the power supply circuit are obtained from windings 5 and 7 of transformer A within the power supply circuit connected in series with windings 5 and 7 of transformer B in the rectifying peak voltmeter circuit.

Add figure 43.1.

Page 107, paragraph 120*c*(3), lines 1 and 2. Change figure 43 to figure 43 or 43.1.

Page 108. Add figure 44.1.

Page 112. Add figure 48.1.

Page 113. Add figure 49.1.

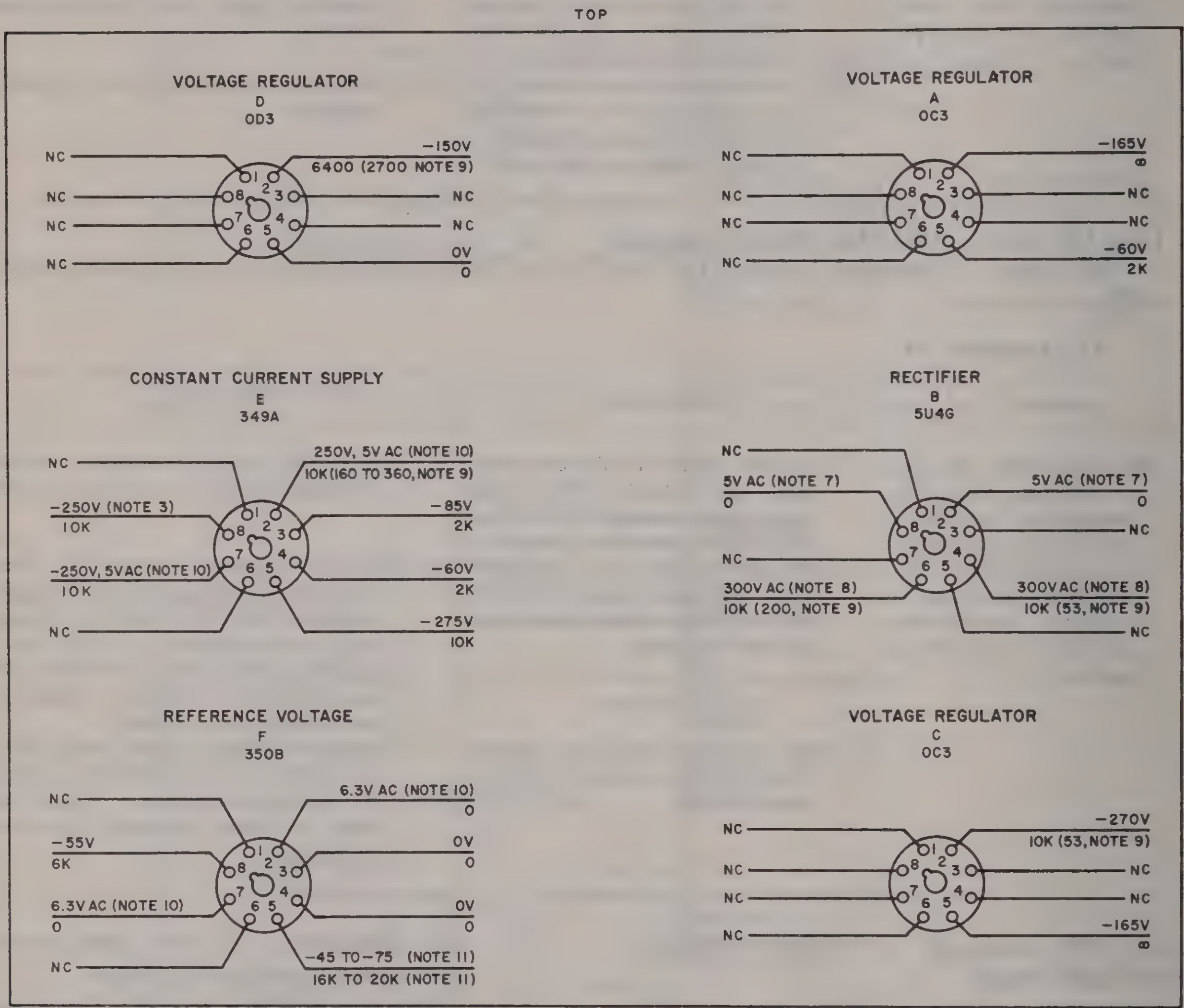
Page 114. Add figure 50.1.

Page 115, figure 51. Add the following note to the figure:

NOTE:

RESISTOR J, USED ON THE TS-611C/FG, IS LOCATED BETWEEN L101 and R104.

Add figure 52.1.



NOTES:

1. VOLTAGES MEASURED TO GROUND, UNLESS OTHERWISE INDICATED, WITH A 1,000 OHMS−PER−VOLT METER.
2. ALL RESISTANCE MEASUREMENTS MADE WITH THE POWER OFF AND FILTER CAPACITORS DISCHARGED.
3. DEPENDING ON POSITION OF CONST CUR POTENTIOMETER.
4. ALL VOLTAGES DC UNLESS OTHERWISE INDICATED.
5. ALL RESISTANCES ARE IN OHMS UNLESS OTHERWISE INDICATED.
6. ALL VOLTAGES POSITIVE UNLESS OTHERWISE INDICATED.
7. MEASURED BETWEEN TERMINALS 2 AND 8.
8. MEASURED BETWEEN TERMINAL 4 OR 6 AND TERMINAL 4 OF INDUCTOR A.
9. WITH LUG 1 OF INDUCTOR A GROUNDED.
10. AC VOLTAGE MEASURED BETWEEN TERMINALS 2 AND 7.
11. DEPENDING ON POSITION OF REF VOLT SWITCH.

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Figure 44.1. (Added) *Voltage and resistance values for the power supply circuits (TS–611C/FG only).*

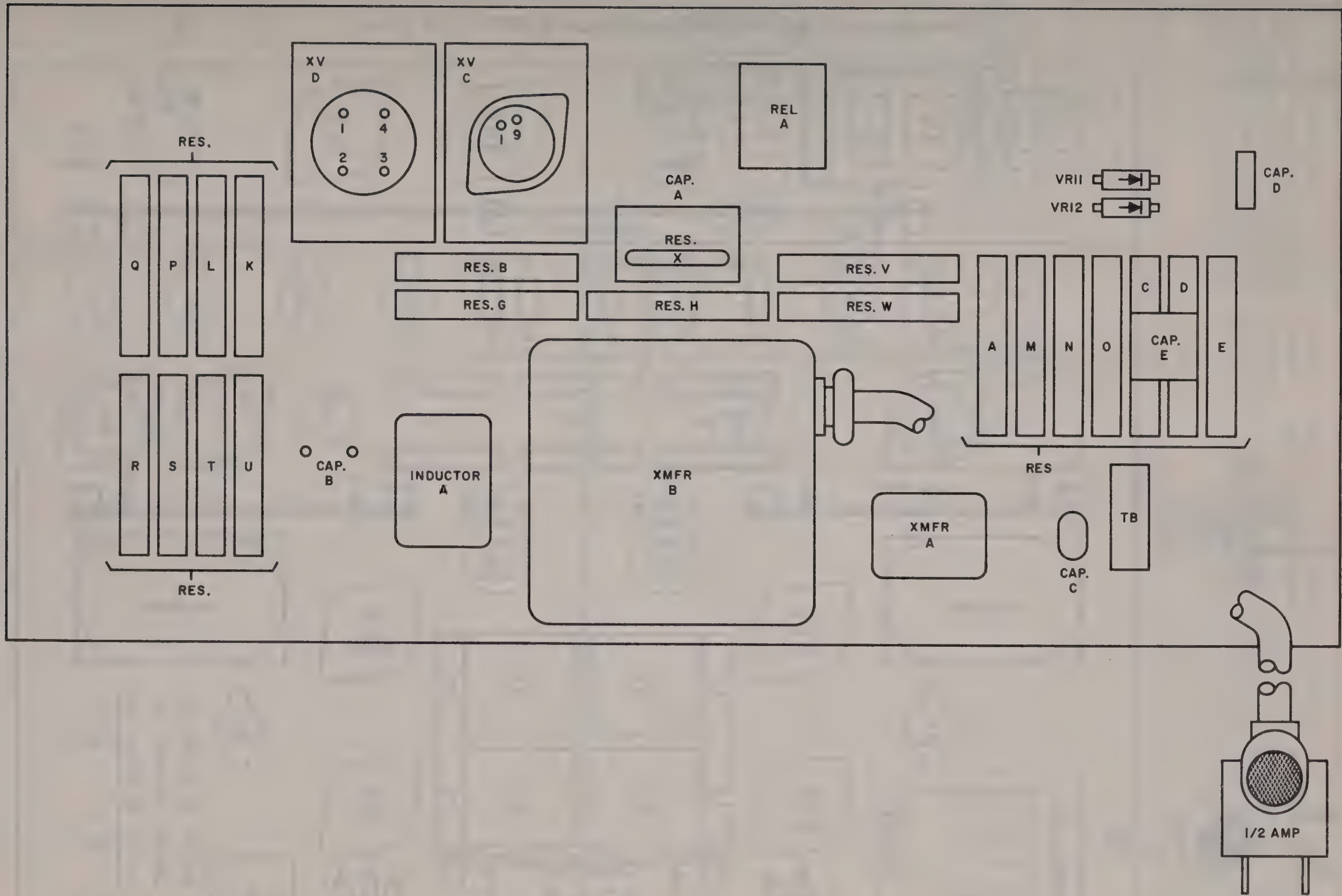

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Figure 48.1. (Added) *RECT PEAK VM panel, rear view, radiation shield removed (TS-611C/FG only).*

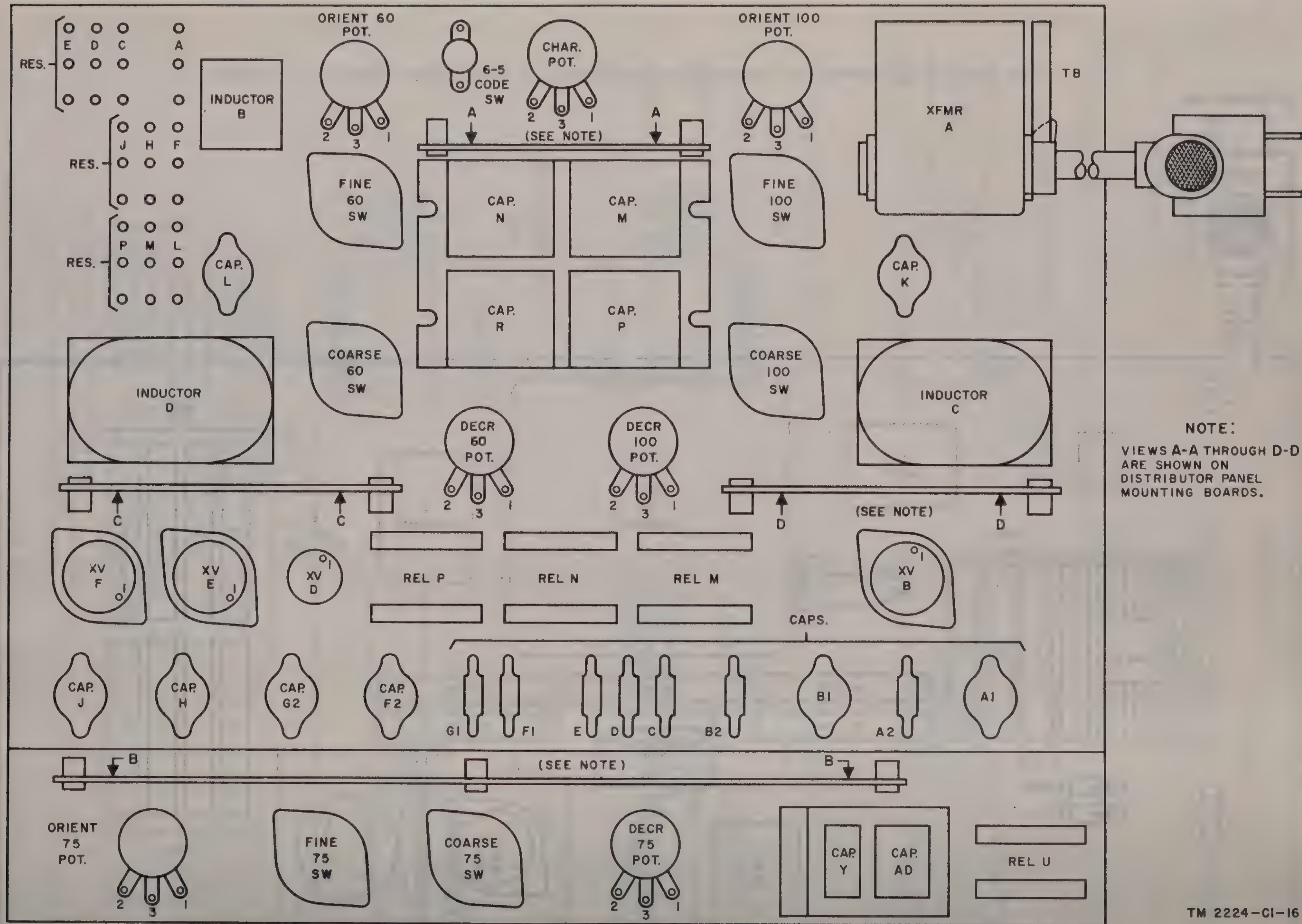


Figure 49.1. (Added) *DISTRIBUTOR panel, rear view (TS-611C/FG only).*

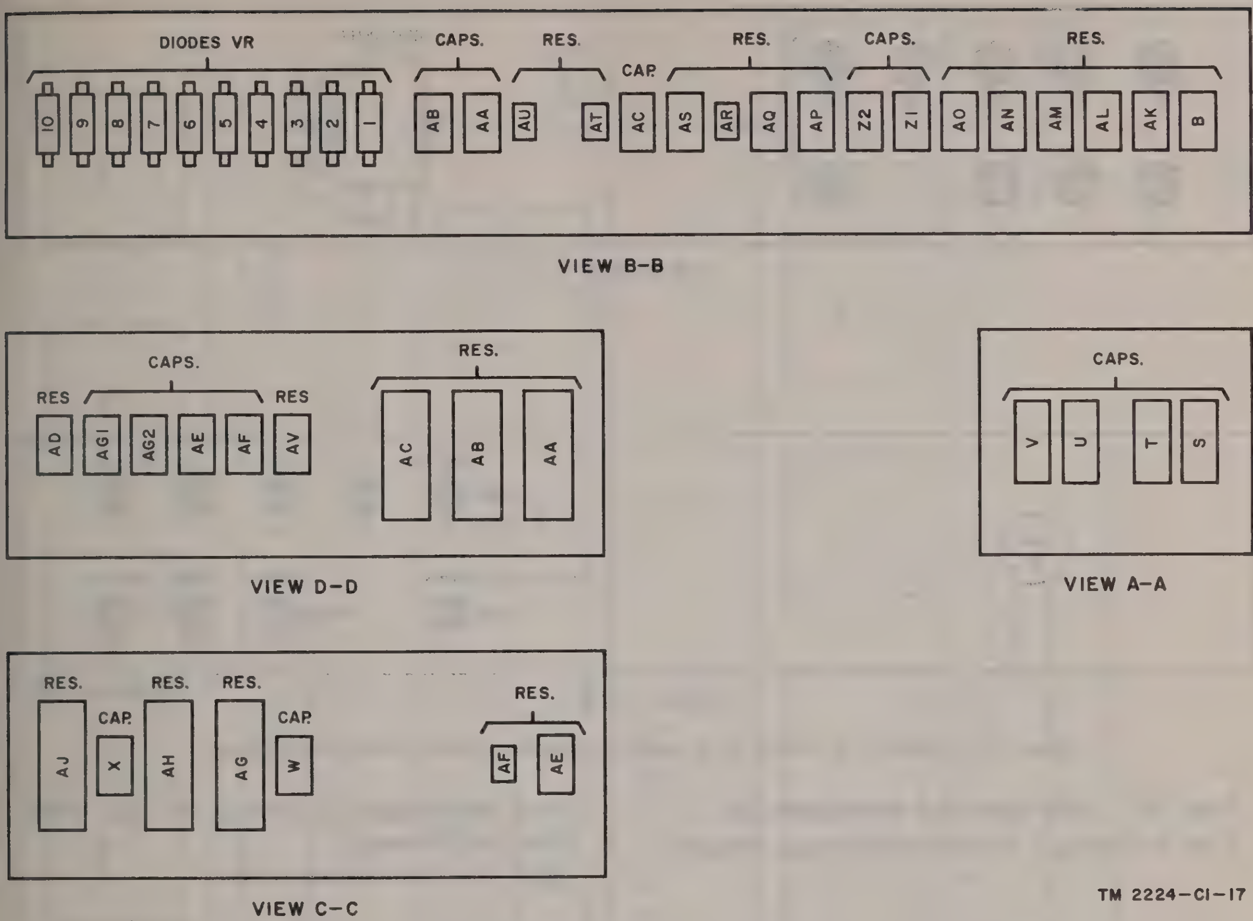


Figure 50.1. (Added) *DISTRIBUTOR panel, mounting boards (TS–611C/FG only).*

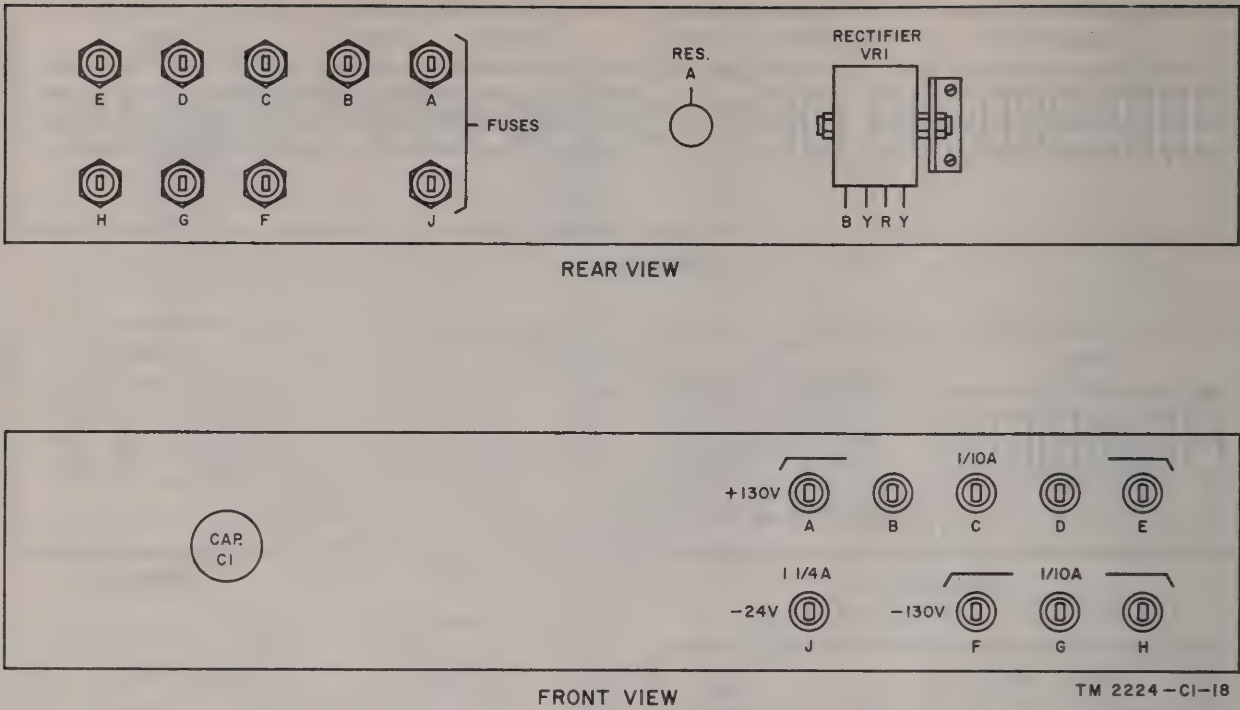


Figure 52.1. (Added) *24-VOLT SUP panel, front and rear view* (*TS–611C/FG only*).

Page 116. Add figure 53.1 after figure 53.

Page 118, table. Make the following changes:

Add subparagraph heading to the table: *a. TS–611A/FG only.*

Add after the existing table:

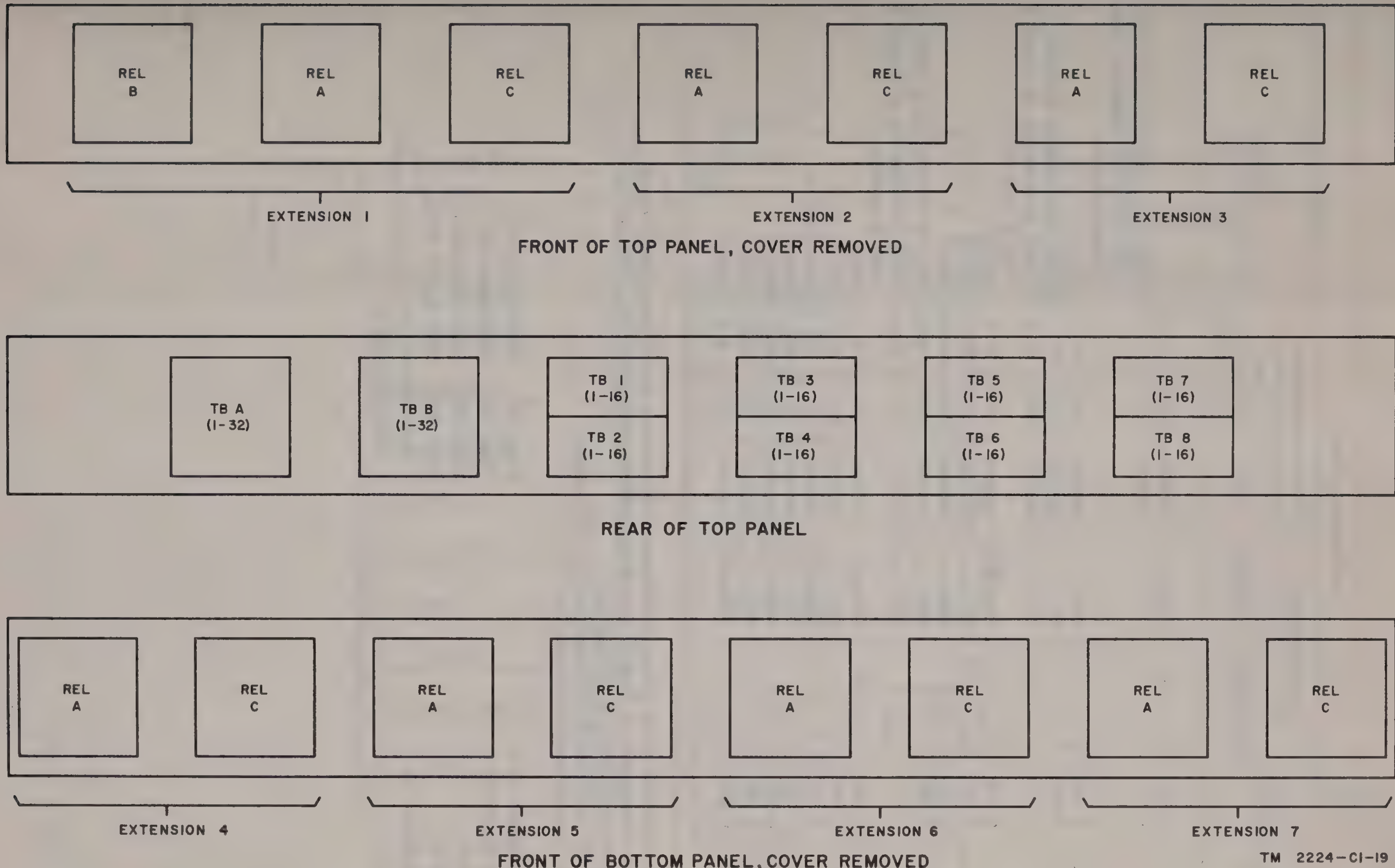


Figure 53.1. (Added) *EXT CKT panels, front and rear views (TS–611C/FG only).*

b. TS–611C/FG Only

Relay Adjustment Table

Relay reference symbols	Applicable spring combination (fig. 54)	Armature travel (in.)	Circuit preparation (Use test clip to connect)			Dc current requirements			Remarks
			Battery to relay	Ground to relay	Test set preparation	Test for	Ma		
							Test	Readjust	
E	4 (2 ea)	0. 029		E	Ground	Operate	20. 5	19. 5	
F	10, 9	0. 047	F		24v	Operate	21	20	Block relay S in operate position. ADJ SPEED switch in non-operate position.
G	3. 8	0. 035	G		24v	Operate	11. 3	10. 7	Note 2.
K	14 (2 ea)	0. 071	K		24v	Operate	47. 5	45	Relay winding alone (note 2).
					24v	Operate	65	61. 5	Circuit combination of relays K and R (note 2).
L	13, 12	0. 059		L	Ground	Operate	39. 5	37. 5	Note 2.
S	2 (2 ea)	0. 047	S		24v	Operate	17. 5	16. 5	Note 2.
H	6 (2 ea)	0. 047	H		24v	Operate	17. 5	16. 5	Note 2.
R	16, 15	0. 029	R		24v	Operate	9. 5	8. 9	Relay R winding alone (note 2).
					24v	Operate	48	45	Circuit combination of relays K and R (note 2).
M	5, 11	0. 050		M	Ground	Operate	20	19	Note 3.
N	1, 7	0. 059	N		24v	Operate	37	35	Note 2.
P	7, 17	0. 059		P	Ground	Operate	33	31	Notes 3 and 4.
U	7, 17	0. 059	U		24v	Operate	33	31	Note 3.
A	13, 12	0. 609		A	Ground	Operate	39. 5	37. 5	Note 2.
B	6 (2 ea)	0. 047	B		24v	Operate	17. 5	16. 5	Note 5.
C	16 (2 ea)	0. 029		C	Ground	Operate	5. 7	5. 4	Note 2.

Notes.

1. Toggle switch (AC) should be off during all adjustment except when testing plug-in polar relays.
2. Plugs should not be connected to TMS IN jack of teletypewriter test set or of any extension unit.
3. Operate 60–75–100 speed switch to 100 position.
4. Operate 60–75–100 speed switch at extension unit to 100 position.
5. Insert plug into TSM IN jack at extension unit.

Page 124. Add figure 59.1.

Page 125. Add figure 60.1.

Add figure 61.1.

Add figure 62.1.

Page 126. Add figure 63.1.

Add figure 64.1.

Page 127. Add figure 65.1.

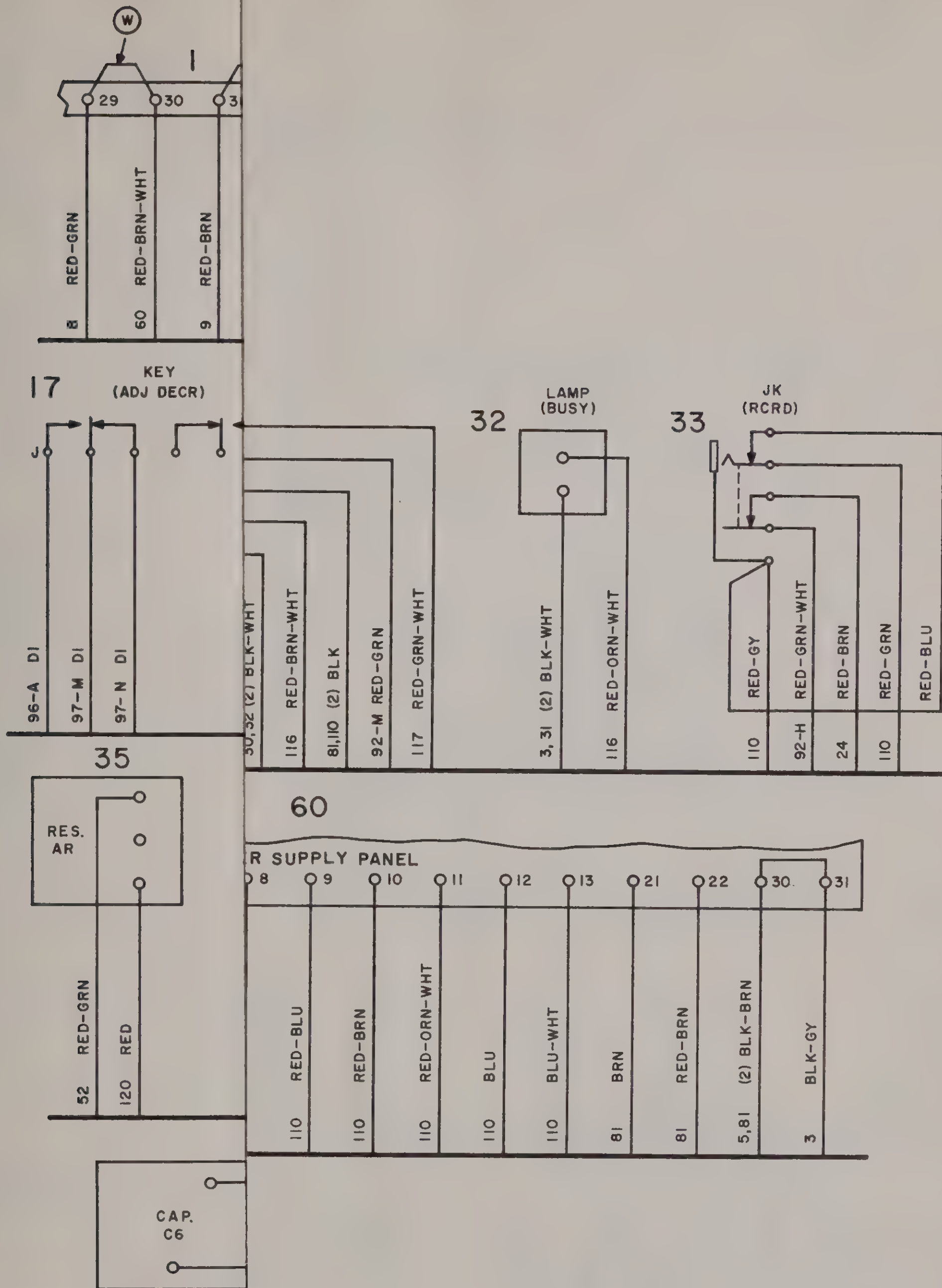
Page 128. Add figure 67.1.

Page 129. Add figure 68.1.

Page 130. Add figure 69.1.

Add figure 71.1.

Add figure 73.1.



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b. TS–611C/FG Only

Relay Adjustment Table

Relay reference symbols	Applicable spring combination (fig. 54)	Armature travel (in.)	Circuit preparation (Use test clip to connect)			Dc current requirements			Remarks
			Battery to relay	Ground to relay	Test set preparation	Test for	Ma		
							Test	Readjust	
E	4 (2 ea)	0.029		E	Ground	Operate	20.5	19.5	
F	10, 9	0.047	F		24v	Operate	21	20	Block relay S in operate position. ADJ SPEED switch in non-operate position.
G	3, 8	0.035	G		24v	Operate	11.3	10.7	Note 2.
K	14 (2 ea)	0.071	K		24v	Operate	47.5	45	Relay winding alone (note 2).
					24v	Operate	65	61.5	Circuit combination of relays K and R (note 2).
L	13, 12	0.059		L	Ground	Operate	39.5	37.5	Note 2.
S	2 (2 ea)	0.047	S		24v	Operate	17.5	16.5	Note 2.
H	6 (2 ea)	0.047	H		24v	Operate	17.5	16.5	Note 2.
R	16, 15	0.029	R		24v	Operate	9.5	8.9	Relay R winding alone (note 2).
					24v	Operate	48	45	Circuit combination of relays K and R (note 2).
M	5, 11	0.050		M	Ground	Operate	20	19	Note 3.
N	1, 7	0.059	N		24v	Operate	37	35	Note 2.
P	7, 17	0.059		P	Ground	Operate	33	31	Notes 3 and 4.
U	7, 17	0.059	U		24v	Operate	33	31	Note 3.
A	13, 12	0.609		A	Ground	Operate	39.5	37.5	Note 2.
B	6 (2 ea)	0.047	B		24v	Operate	17.5	16.5	Note 5.
C	16 (2 ea)	0.029		C	Ground	Operate	5.7	5.4	Note 2.

Notes.

1. Toggle switch (AC) should be off during all adjustment except when testing plug-in polar relays.
2. Plugs should not be connected to TMS IN jack of teletypewriter test set or of any extension unit.
3. Operate 60–75–100 speed switch to 100 position.
4. Operate 60–75–100 speed switch at extension unit to 100 position.
5. Insert plug into TSM IN jack at extension unit.

Page 124. Add figure 59.1.
Page 125. Add figure 60.1.
Add figure 61.1.
Add figure 62.1.
Page 126. Add figure 63.1.
Add figure 64.1.
Page 127. Add figure 65.1.
Page 128. Add figure 67.1.
Page 129. Add figure 68.1.
Page 130. Add figure 69.1.
Add figure 71.1.
Add figure 73.1.

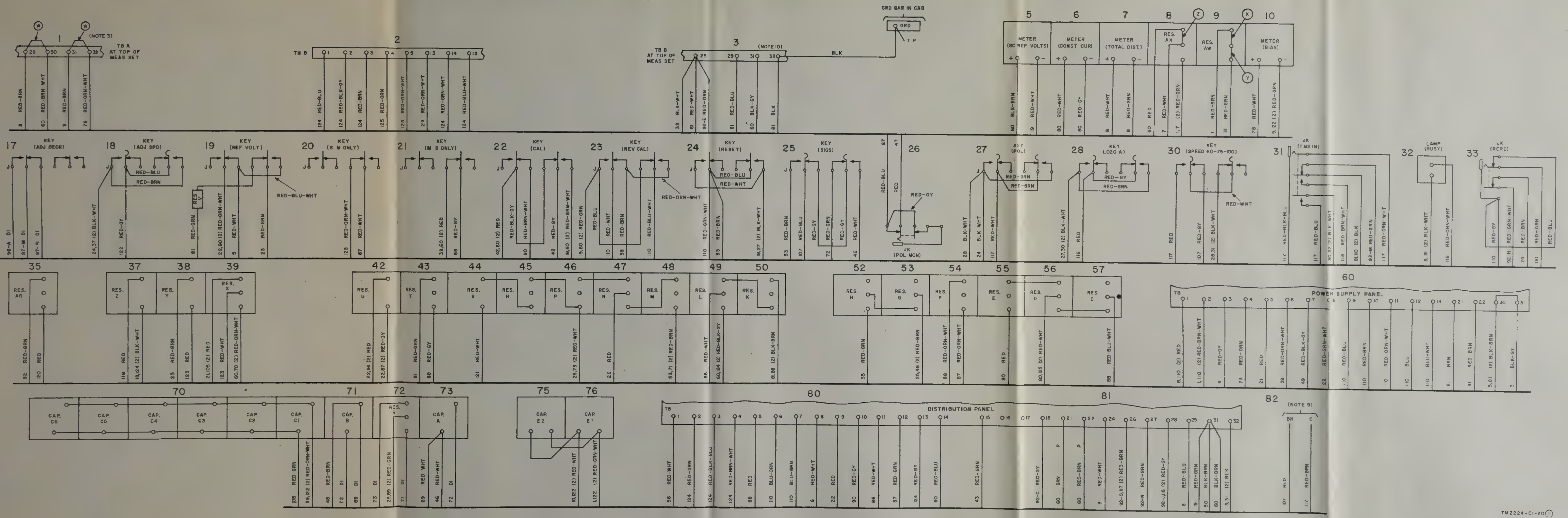
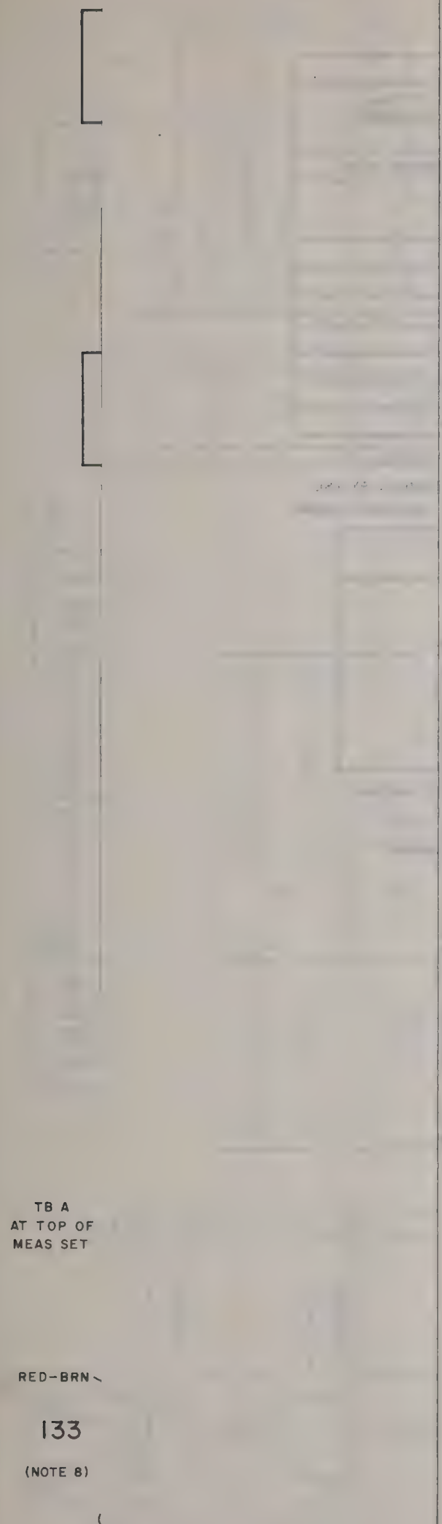
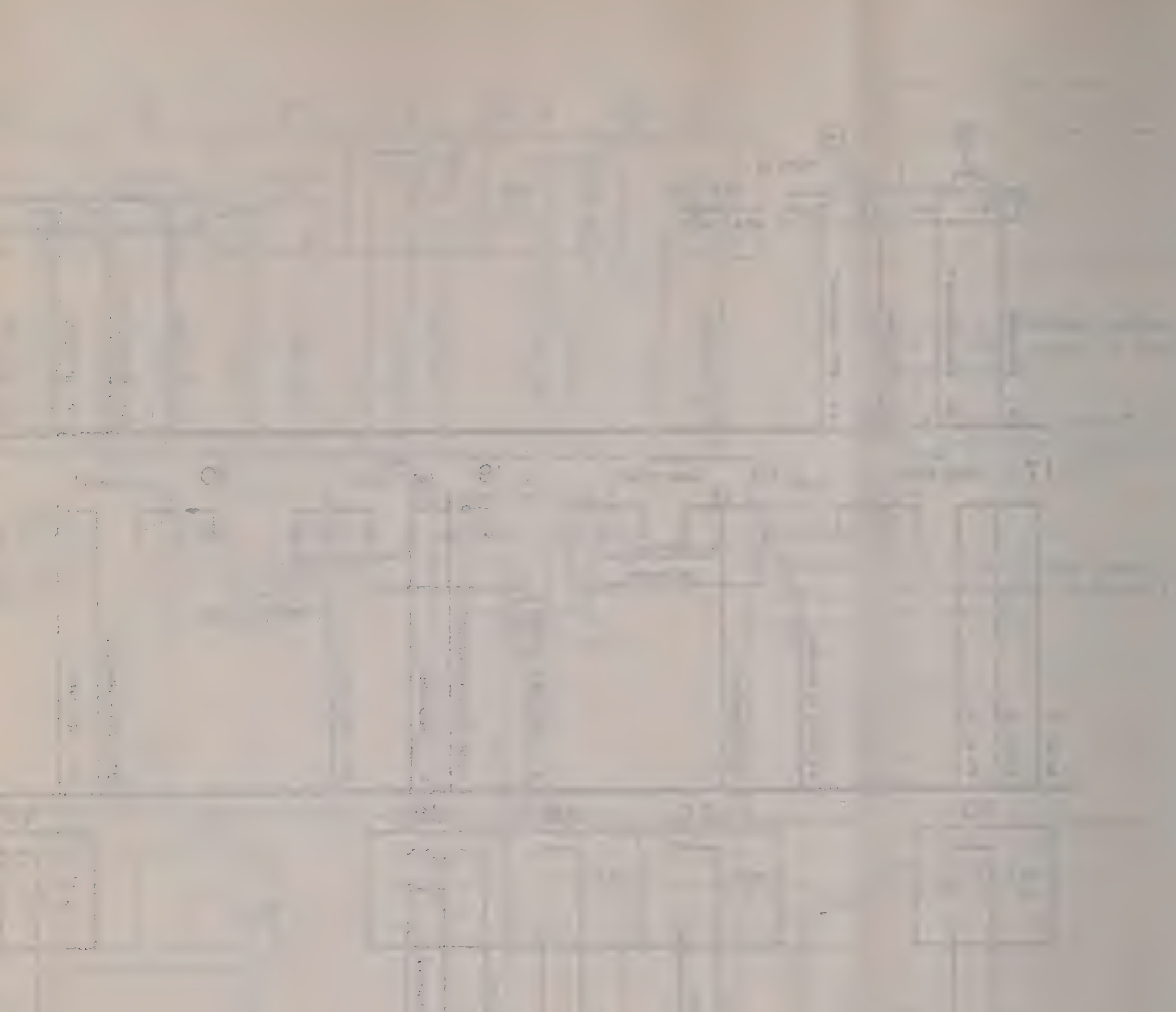
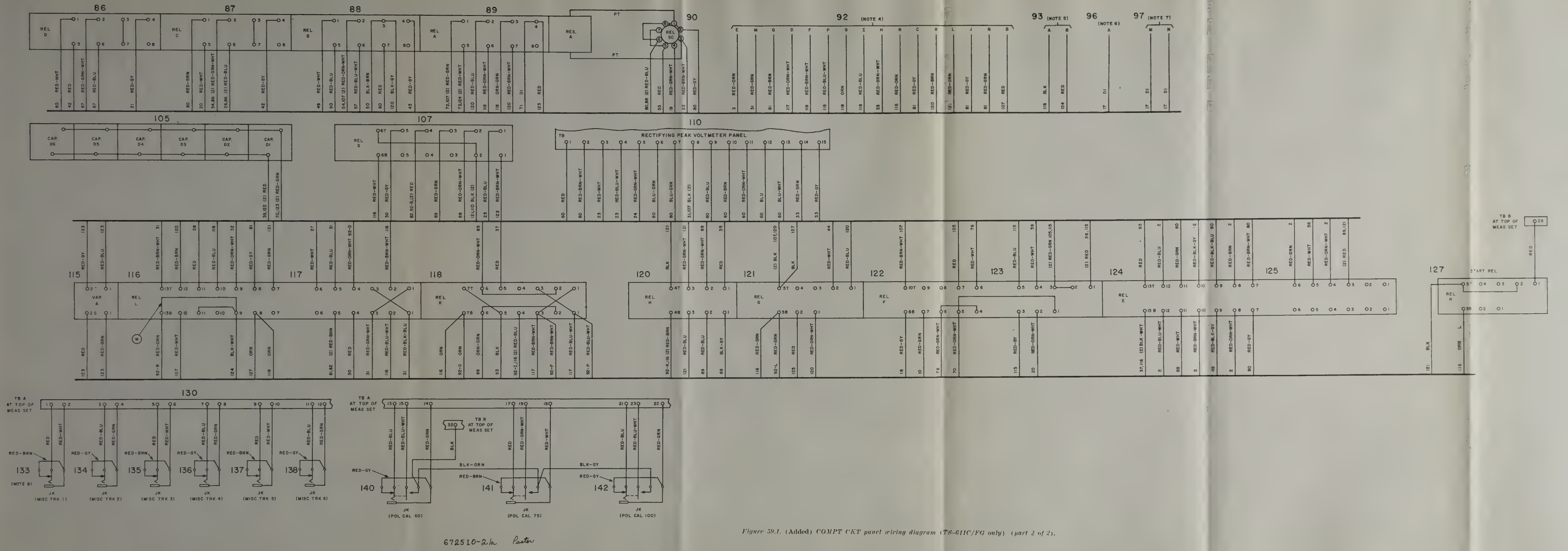


Figure 59.1. (Added) COMPT CKT panel wiring diagram (TS-611C/FG) only) (part 1 of 2).

672510 O - 63 (Face p. 30) No. 1


TB A
AT TOP OF
MEAS SET
RED-BRN
133
(NOTE 8)





NOTES:

1

SYMBOL	EXPLANATION
DI	20 GA BLACK LEADS NOT INCLUDED IN A LOCAL CABLE, BUT RUN DIRECTLY BETWEEN TERMINALS IN THE SHORTEST POSSIBLE MANNER
J	TOP OR LEFT SIDE OF SWITCH, LOOKING AT TERMINAL SIDE.
L	LIVE LEAD WHICH MUST BE INSULATED, WHEN NOT CONNECTED TO APPARATUS.
P	PAIR OF WIRES
PT	LEADS THAT ARE PART OF APPARATUS
TP	TIE POINTS

2. ALL STRAPS ARE BARE 20 GA WIRE UNLESS OTHERWISE SPECIFIED

3. USE OF STRAPPING OPTIONS W, X, Y, AND Z IS DETERMINED BY THE NUMBER OF EXTENSION UNITS USED WITH THE TEST SET. SEE THE CHART BELOW

NUMBER OF EXTENSION UNITS USED	STRAPPING OPTIONS REQUIRED
NONE	W
1 OR 2	NONE
3	X
4 OR 5	X AND Y
6, 7 OR 8	Y AND Z
9 OR MORE	X, Y, AND Z

4. REFER TO STATION 38 OF EXTENSION CIRCUIT PANELS WIRING DIAGRAM

5. REFER TO AC SUPPLY CIRCUIT WIRING DIAGRAM

6. REFER TO STATION 53 OF DISTRIBUTOR CIRCUIT WIRING DIAGRAM

7. REFER TO STATION 23 OF RECTIFIER PEAK VM PANEL WIRING DIAGRAM

8. STATIONS 130 THROUGH 142 ARE PATCHING FACILITIES FOR USING EXTERNAL TEST EQUIPMENT. JACK APPEARANCES ARE PHYSICALLY LOCATED ON THE JACK AND KEY PANEL.

9. REFER TO STATION 67 OF DISTRIBUTOR PANEL WIRING DIAGRAM

10. STRAP TERMINALS 31 AND 32 WHEN FUSE TO GRD NOT USED

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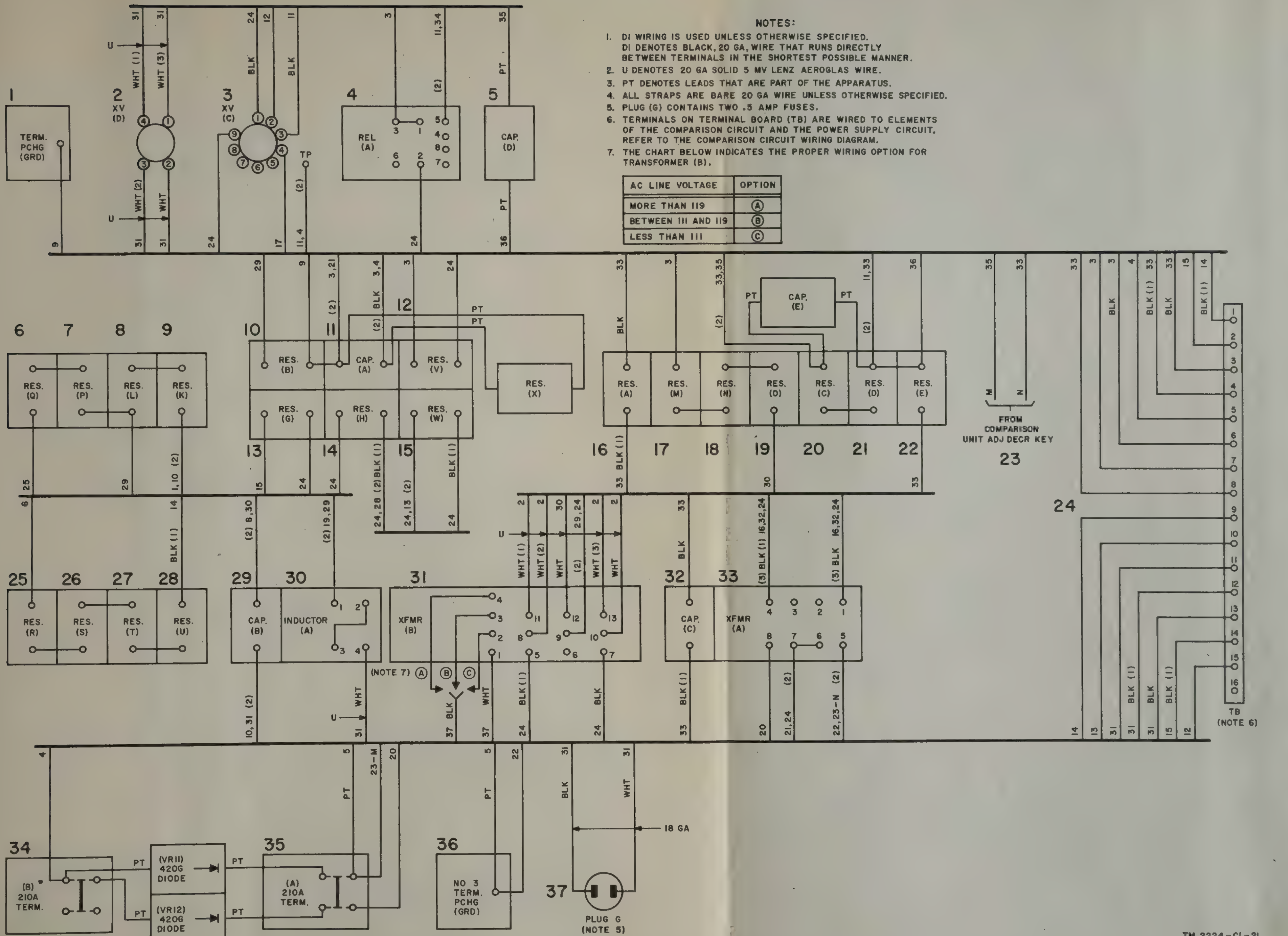
Figure 59.1. (Added) COMPT CKT panel wiring diagram (TS-611C/FG only) (part 2 of 2).



NOTES:

1. DI WIRING IS USED UNLESS OTHERWISE SPECIFIED. DI DENOTES BLACK, 20 GA, WIRE THAT RUNS DIRECTLY BETWEEN TERMINALS IN THE SHORTEST POSSIBLE MANNER.
2. U DENOTES 20 GA SOLID 5 MV LENZ AEROGLAS WIRE.
3. PT DENOTES LEADS THAT ARE PART OF THE APPARATUS.
4. ALL STRAPS ARE BARE 20 GA WIRE UNLESS OTHERWISE SPECIFIED.
5. PLUG (G) CONTAINS TWO .5 AMP FUSES.
6. TERMINALS ON TERMINAL BOARD (TB) ARE WIRED TO ELEMENTS OF THE COMPARISON CIRCUIT AND THE POWER SUPPLY CIRCUIT. REFER TO THE COMPARISON CIRCUIT WIRING DIAGRAM.
7. THE CHART BELOW INDICATES THE PROPER WIRING OPTION FOR TRANSFORMER (B).

AC LINE VOLTAGE	OPTION
MORE THAN 119	A
BETWEEN 111 AND 119	B
LESS THAN 111	C

Figure 60.1. (Added) *RECT PEAK VM panel, wiring diagram (TS–61C/FG only).*

672510 O - 63 (Face p. 30) No. 3

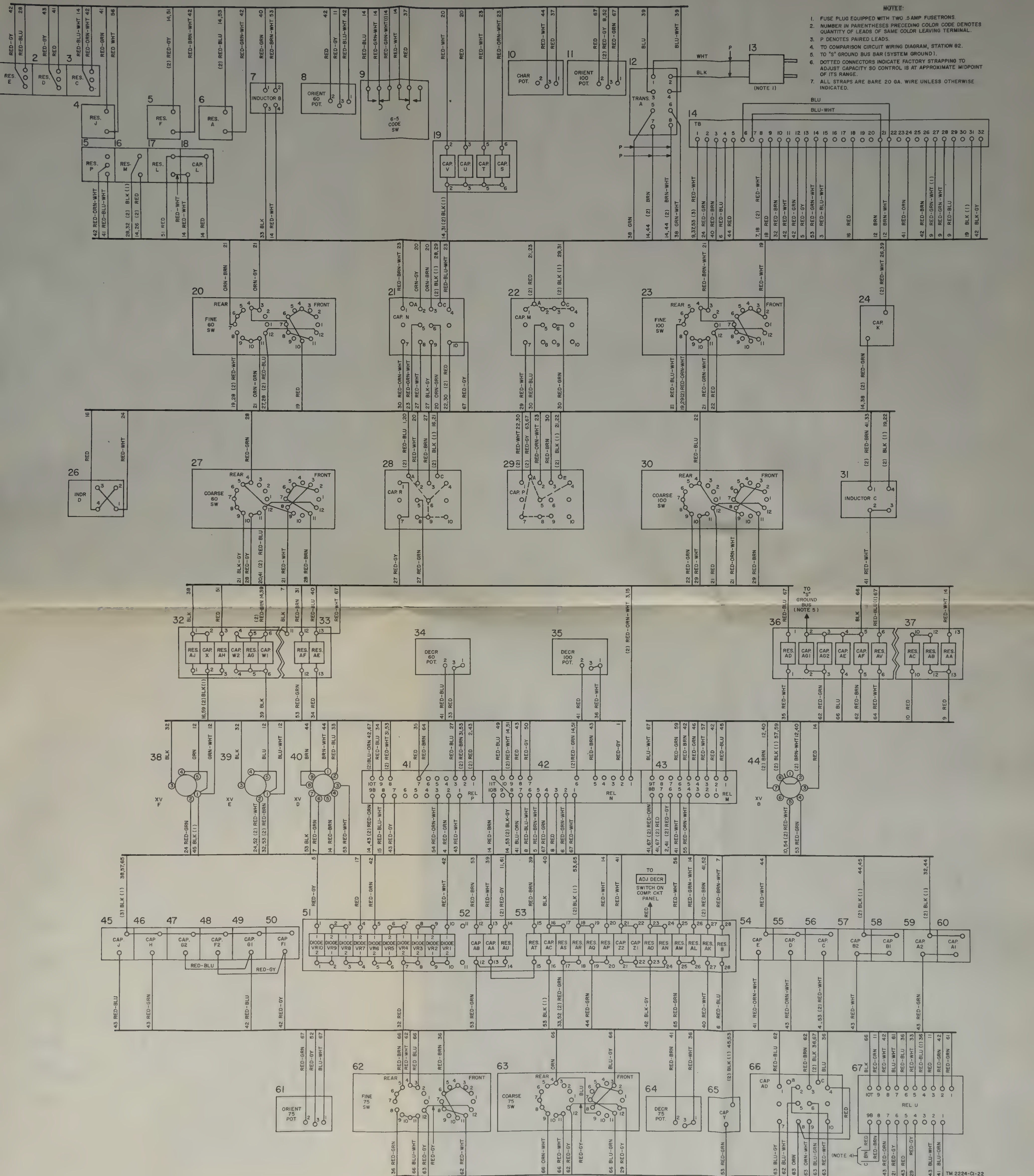
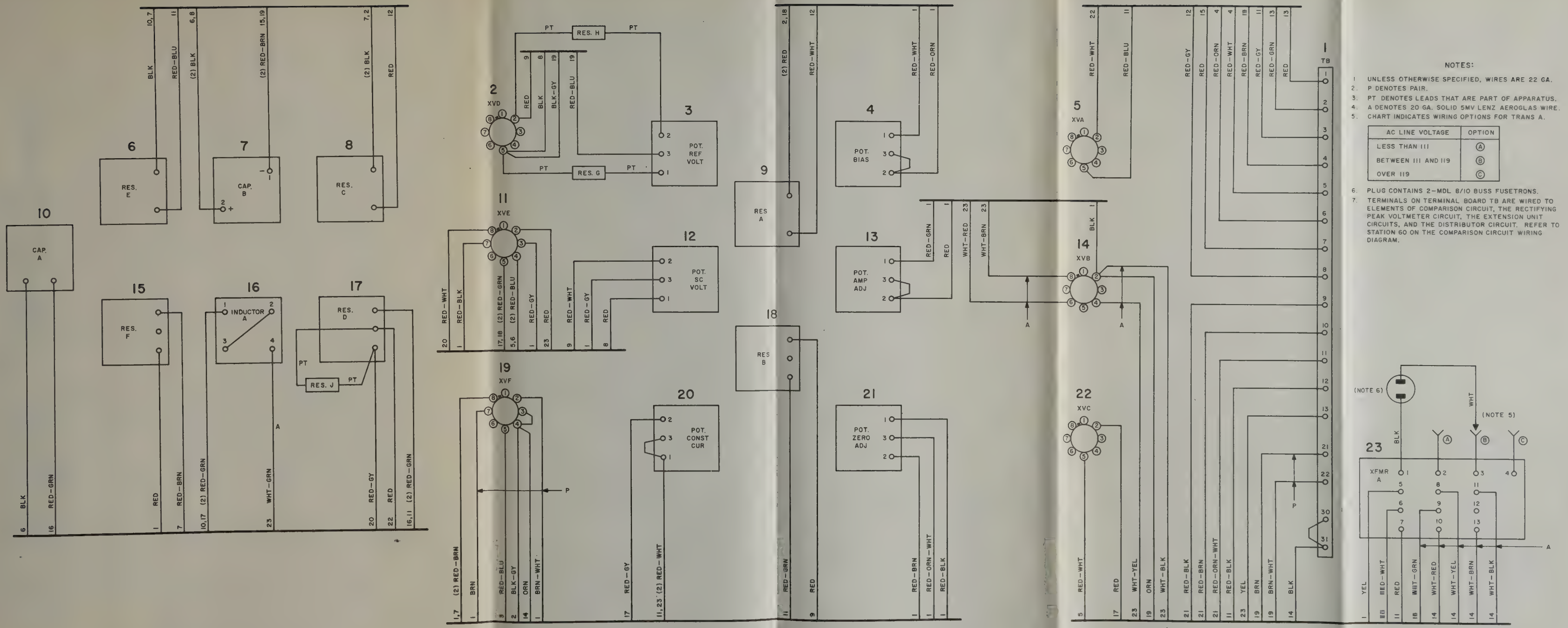


Figure 61.1. (Added) *DISTRIBUTOR panel wiring diagram (TS-611C/FG only).*



NOTES:

1. UNLESS OTHERWISE SPECIFIED, WIRES ARE 22 GA.
2. P DENOTES PAIR.
3. PT DENOTES LEADS THAT ARE PART OF APPARATUS.
4. A DENOTES 20 GA. SOLID 5MV LENZ AEROGLAS WIRE.
5. CHART INDICATES WIRING OPTIONS FOR TRANS A.

AC LINE VOLTAGE	OPTION
LESS THAN 111	A
BETWEEN 111 AND 119	B
OVER 119	C

6. PLUG CONTAINS 2-MDL 8/10 BUSS FUSETRONS.
7. TERMINALS ON TERMINAL BOARD TB ARE WIRED TO ELEMENTS OF COMPARISON CIRCUIT, THE RECTIFYING PEAK VOLTMETER CIRCUIT, THE EXTENSION UNIT CIRCUITS, AND THE DISTRIBUTOR CIRCUIT. REFER TO STATION 60 ON THE COMPARISON CIRCUIT WIRING DIAGRAM.

Figure 62.1. (Added) PWR SUP panel, wiring diagram (TS-611C/FG only).

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672510 O - 63 (Face p. 30) No. 5

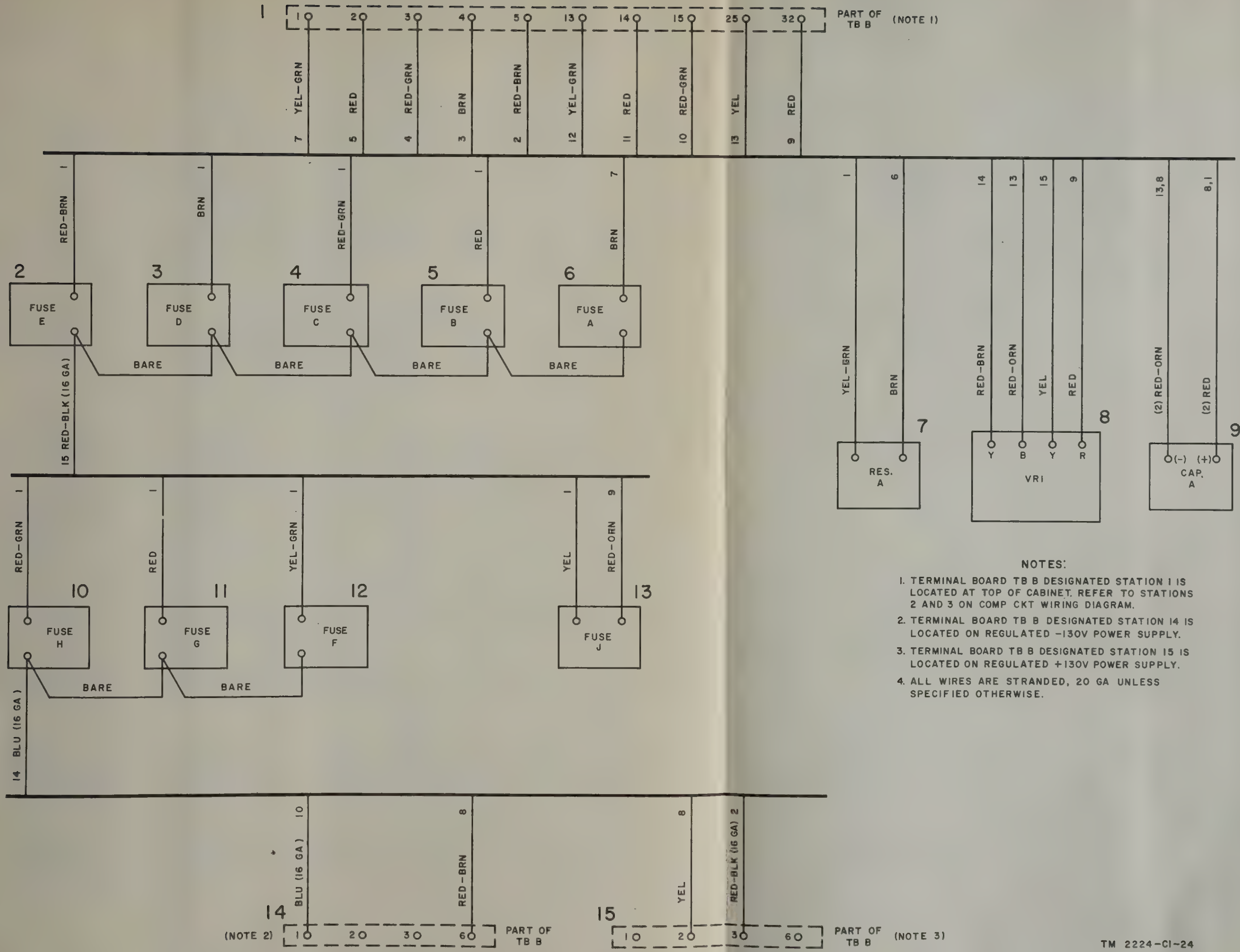


Figure 63.1. (Added) *24 VOLT SUP panel, wiring diagram (TS-611C/FG only).*

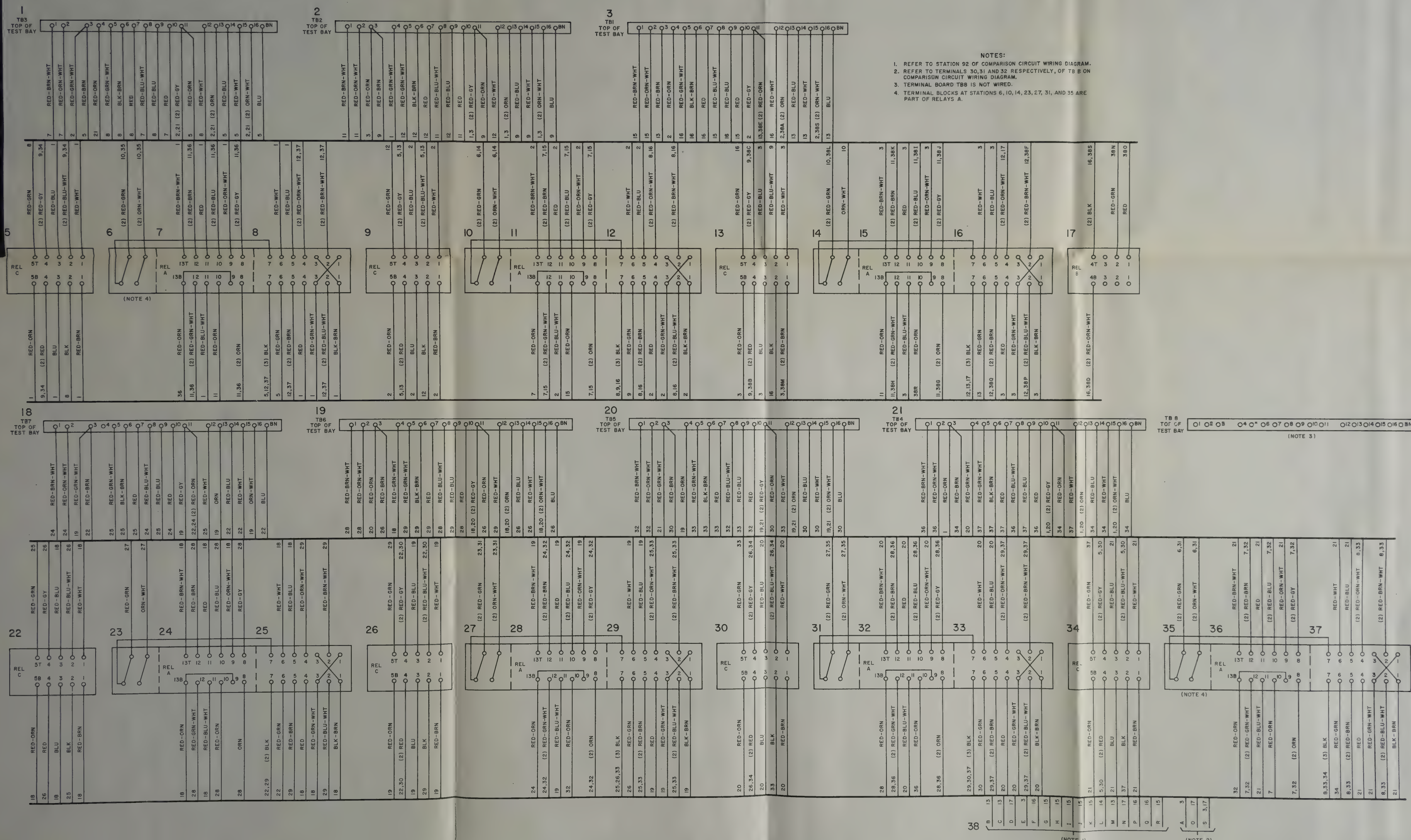


Figure 64.1. (Added) *EXT CKT panels, wiring diagram (TS-611C/FG only).*

672510 O - 63 (Face p. 30) No. 7

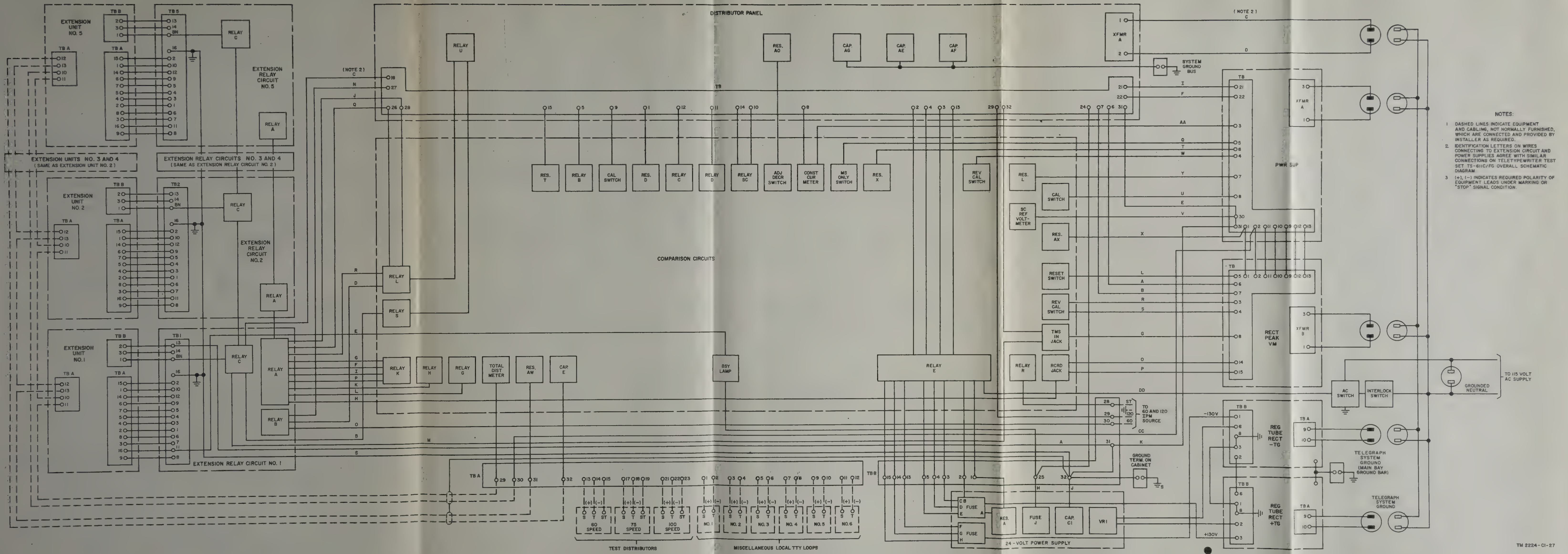


Figure 67.1. (Added) *Teletypewriter Test Set TS–611C/FG, interconnection diagram.*

672510 O - 63 (Face p. 30) No. 8

NOTES:

1. UNLESS OTHERWISE INDICATED, RESISTORS AND INDUCTORS ARE IN OHMS, CAPACITORS ARE IN UF.
2. CONNECTIONS TO TAPS 2, 3, AND 4 ON TRANSFORMER B MAY BE CHANGED TO COMPENSATE FOR INPUT VOLTAGE VARIATIONS.
3. FOR CONNECTIONS TO OTHER CIRCUITS, SEE OVERALL SCHEMATIC AND INTERCONNECTION DIAGRAMS.

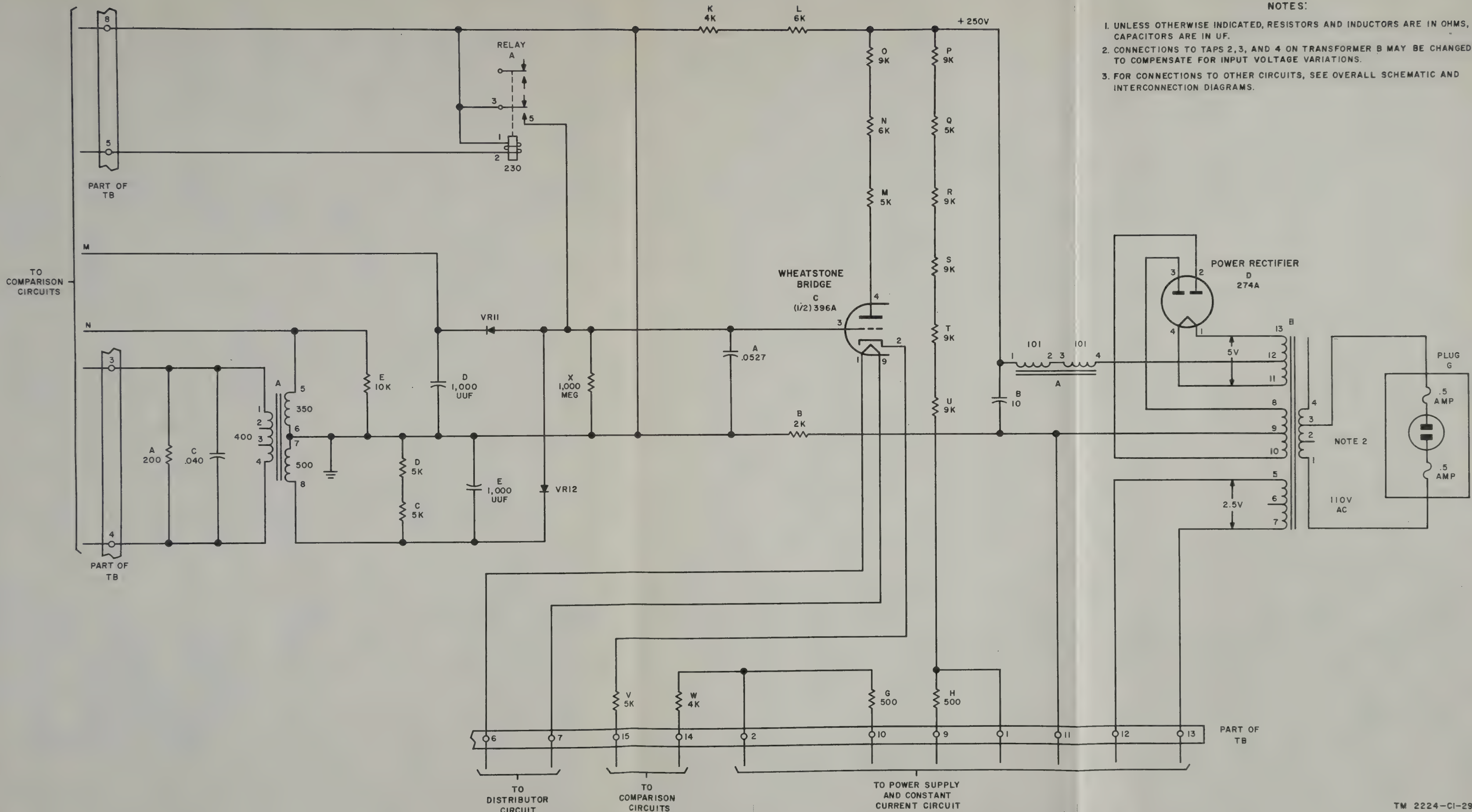


Figure 69.1. (Added) *Rectifying peak voltmeter circuit, schematic diagram (TS-611C/FG only).*

672510 O - 63 (Face p. 32) No. 1

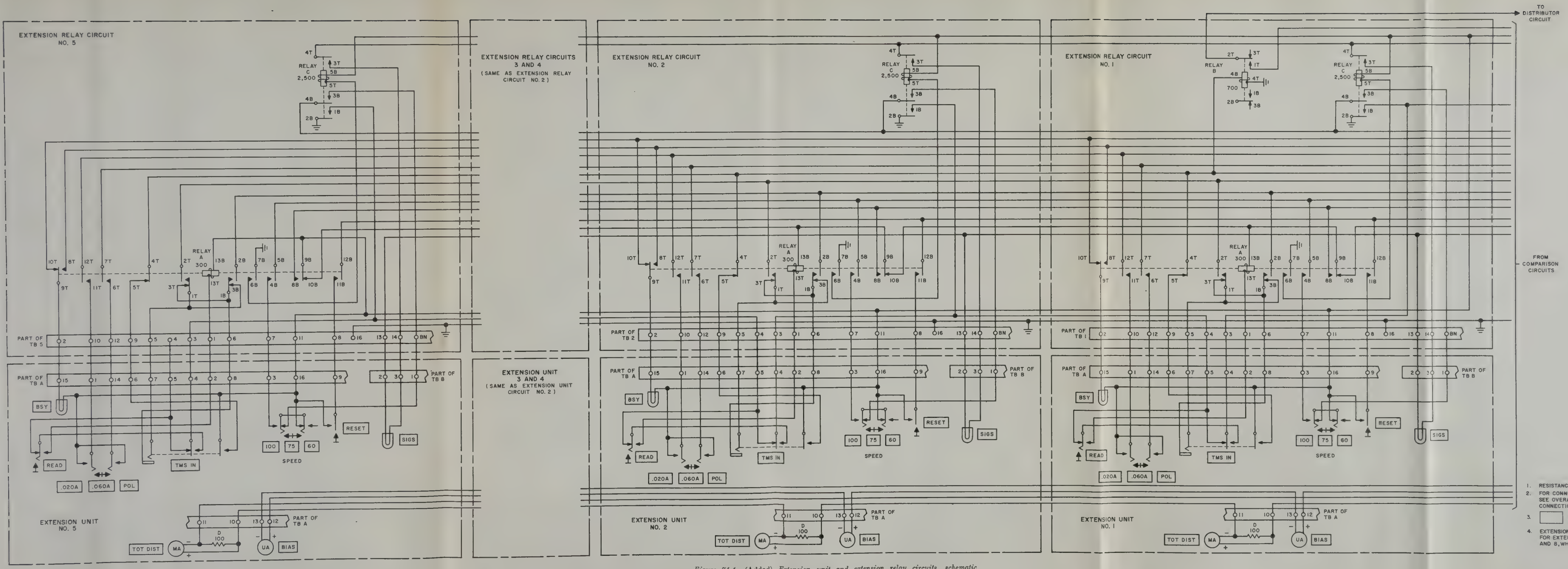


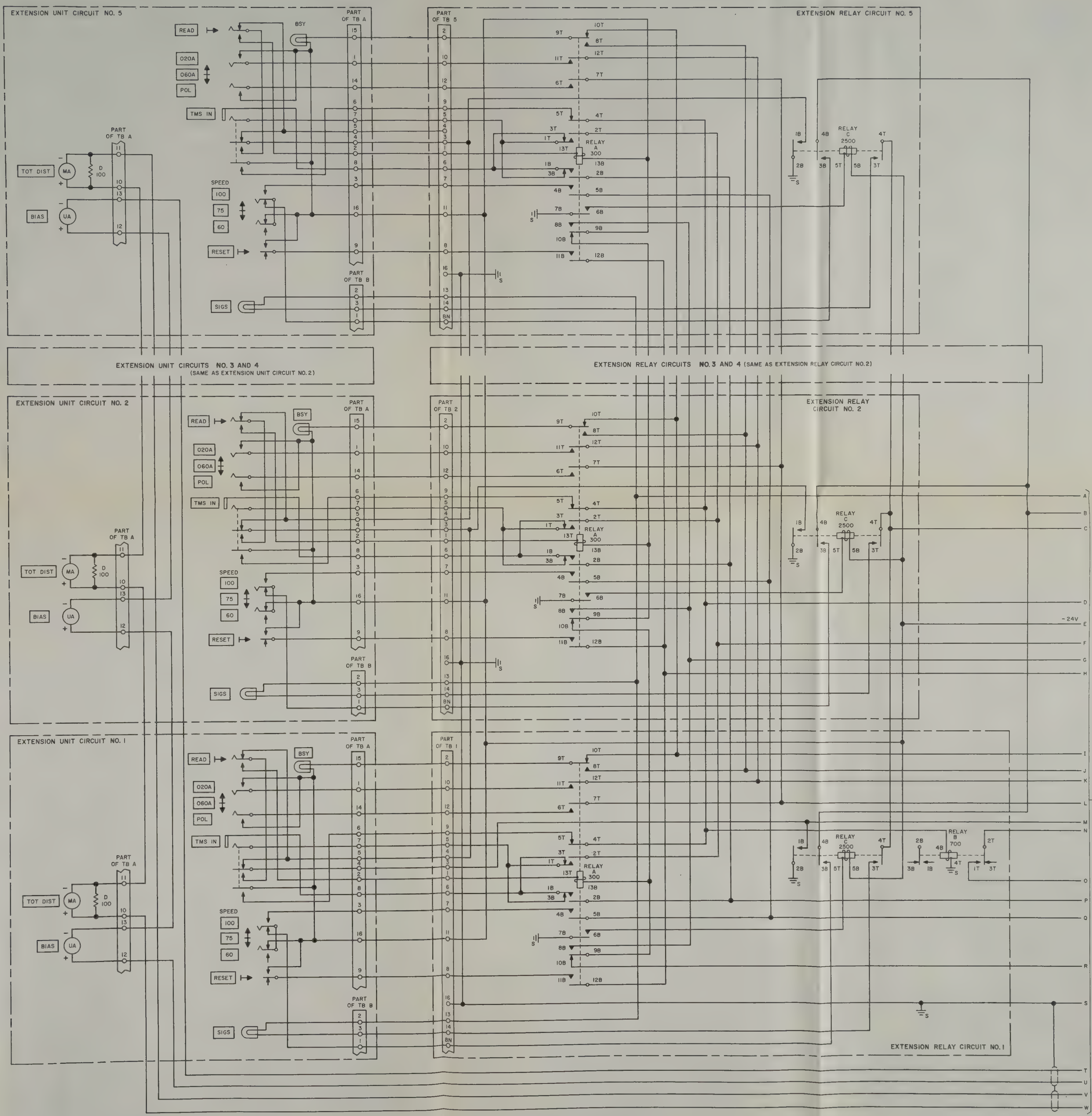
Figure 71.1. (Added) *Extension unit and extension relay circuits, schematic diagram (TS-611C/FG only).*

NOTES:

1. RESISTANCES ARE IN OHMS.
2. FOR CONNECTIONS TO OTHER CIRCUITS, SEE OVERALL SCHEMATIC AND INTERCONNECTION DIAGRAMS.
3. ☐ INDICATES EQUIPMENT MARKINGS.
4. EXTENSION UNITS ARE NOT SUPPLIED FOR EXTENSION RELAY CIRCUITS NO. 7 AND 8, WHICH ARE NOT SHOWN.

TM2224-C1-30

672510 O - 63 (Face p. 32) No. 2



TM 2224-C1-31

Figure 73.1. (Added) Teletypewriter Test Set TS-611C/FG, overall schematic diagram (part 1 of 3).

672510 O - 63 (Face p. 32) No. 3

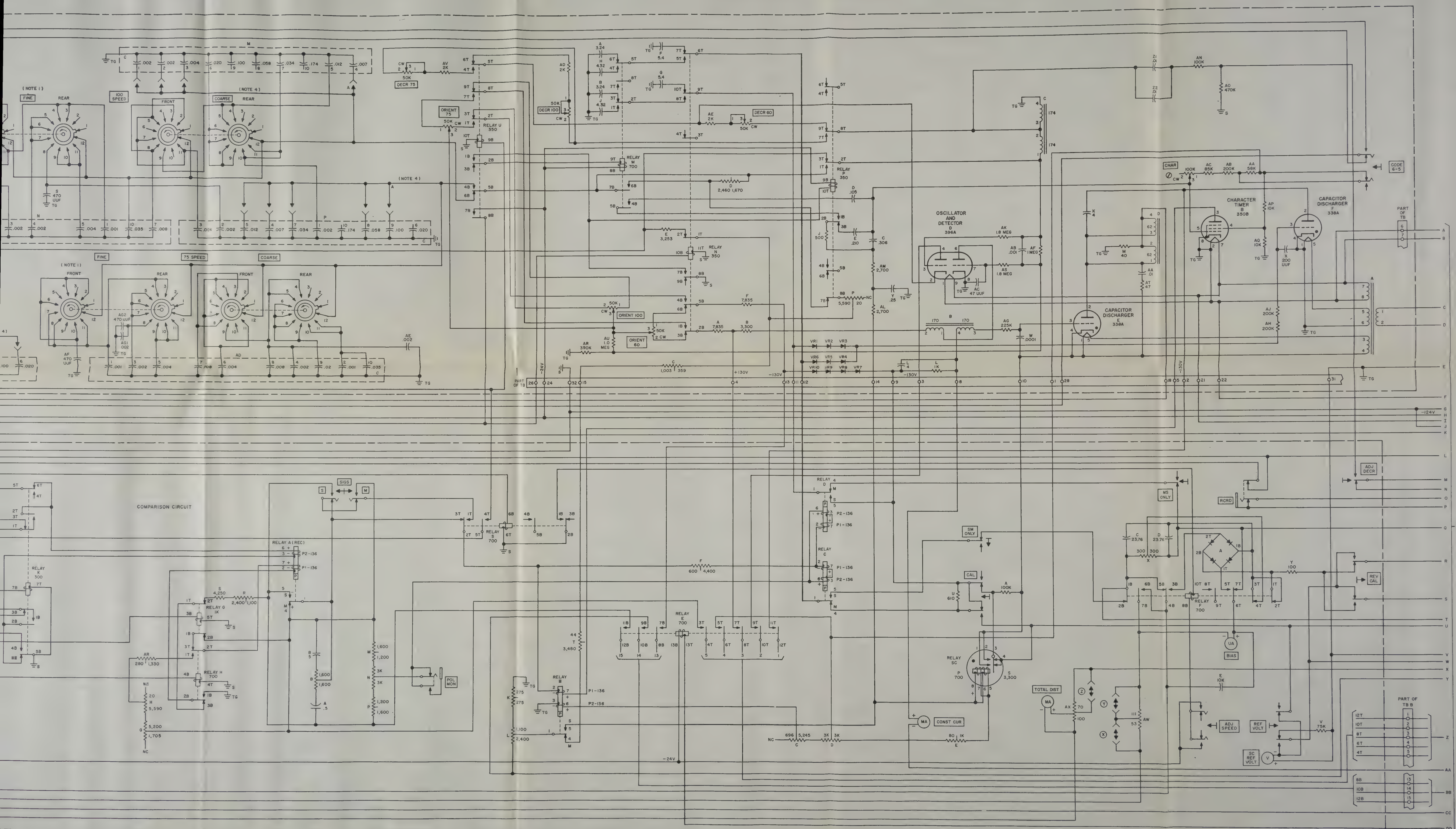


Figure 73.1. (Added) Teletypewriter Test Set TS-611C/FG, overall schematic diagram (part 2 of 3).

TM 2224-31 ②

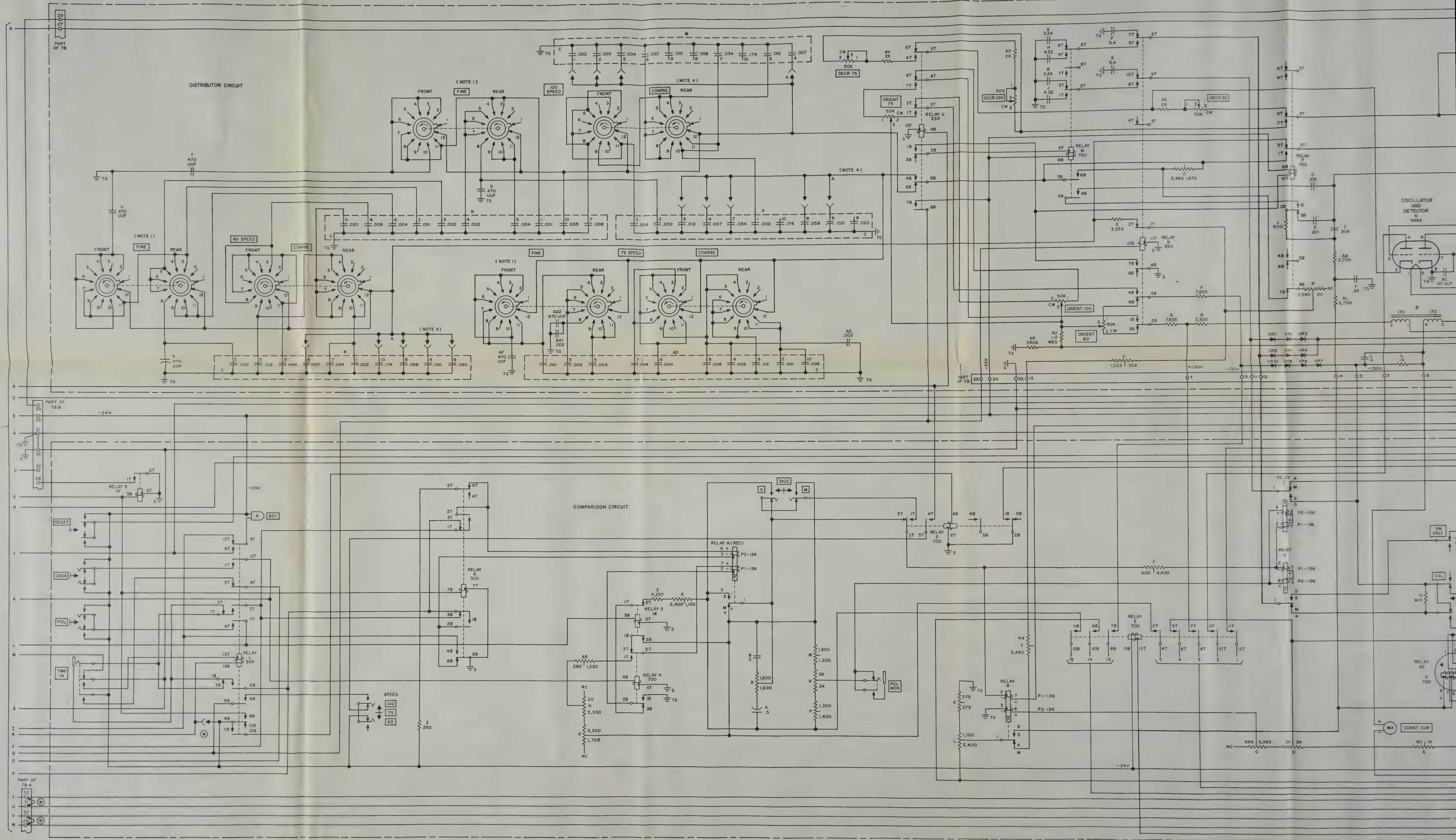
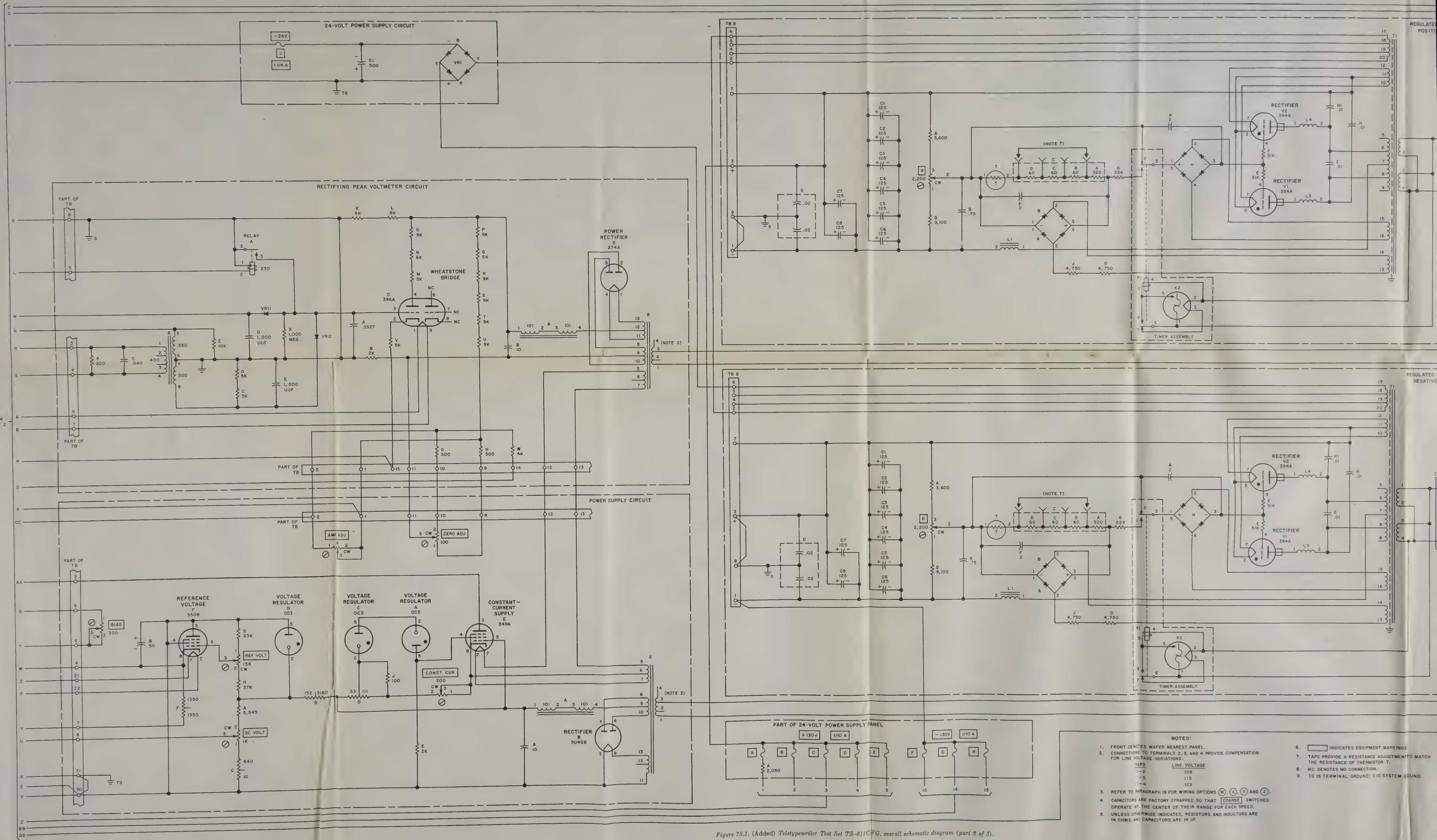


Figure 73.1. (Added) Teletypewriter Test Set TS-611C/FG, overall schematic diagram (part 2 of 5).

672310 O - 63 (Face p. 32) No. 4



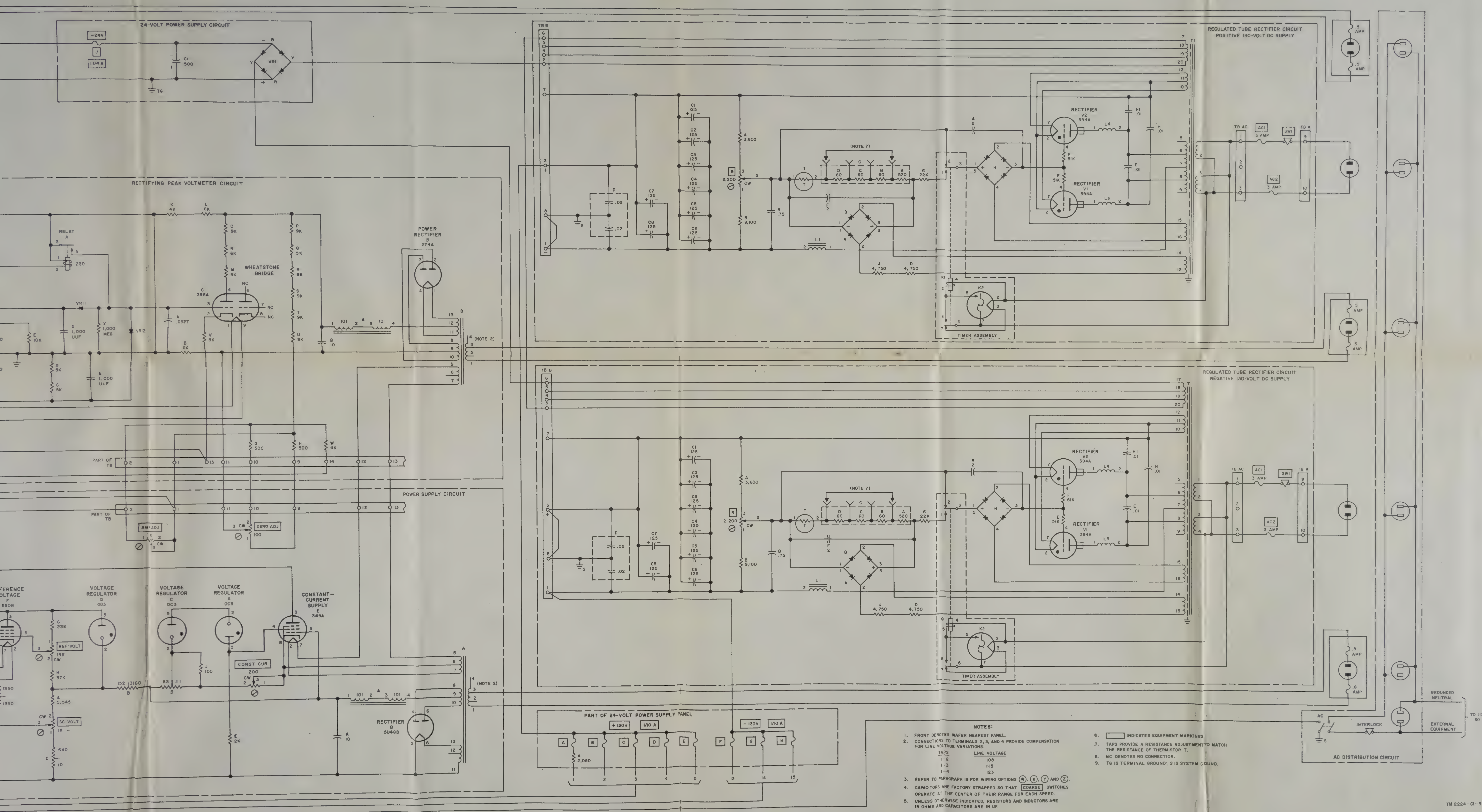
NOTES:

1. FRONT DENOTES WAFER NEAREST PANEL.
2. CONNECTIONS TO TERMINALS 2, 3, AND 4 PROVIDE COMPENSATION FOR LINE VOLTAGE VARIATIONS:

TAPS	LINE VOLTAGE
1-2	108
-3	115
-4	123

3. REFER TO PARAGRAPH 19 FOR WIRING OPTIONS (W), (X), (Y) AND (Z).
4. CAPACITORS ARE FACTORY STRAPPED SO THAT [COARSE] SWITCHES OPERATE AT THE CENTER OF THEIR RANGE FOR EACH SPEED.
5. UNLESS OTHERWISE INDICATED, RESISTORS AND INDUCTORS ARE IN OHMS AND CAPACITORS ARE IN UF.
6. [ ] INDICATES EQUIPMENT MARKINGS
7. TAPS PROVIDE A RESISTANCE ADJUSTMENT TO MATCH THE RESISTANCE OF THERMISTOR T.
8. NC DENOTES NO CONNECTION.
9. TG IS TERMINAL GROUND; S IS SYSTEM GOUND.

Figure 73.1. (Added) Teletypewriter Test Set TS-611C/FG, overall schematic diagram (part 3 of 5).



NOTES:

1. FRONT DENOTES WAFER NEAREST PANEL.
2. CONNECTIONS TO TERMINALS 2, 3, AND 4 PROVIDE COMPENSATION FOR LINE VOLTAGE VARIATIONS:

TAPS	LINE VOLTAGE
1-2	108
1-3	115
1-4	123

3. REFER TO PARAGRAPH 19 FOR WIRING OPTIONS W, X, Y AND Z.
4. CAPACITORS ARE FACTORY STRAPPED SO THAT $\boxed{\text{COARSE}}$ SWITCHES OPERATE AT THE CENTER OF THEIR RANGE FOR EACH SPEED.
5. UNLESS OTHERWISE INDICATED, RESISTORS AND INDUCTORS ARE IN OHMS AND CAPACITORS ARE IN UF.
6. $\boxed{\quad}$ INDICATES EQUIPMENT MARKINGS
7. TAPS PROVIDE A RESISTANCE ADJUSTMENTTO MATCH THE RESISTANCE OF THERMISTOR T.
8. NC DENOTES NO CONNECTION.
9. TG IS TERMINAL GROUND; S IS SYSTEM GOUND.

TM 2224-CI-31 (3)

Figure 73.1. (Added) Teletypewriter Test Set TS-611C/FG, overall schematic diagram (part 3 of 3).

By Order of the Secretary of the Army:

EARLE G. WHEELER,
General, United States Army,
Chief of Staff.

Official:
J. C. LAMBERT,
Major General, United States Army,
The Adjutant General.

Distribution:
Active Army:

USASA (2)
CNGB (1)
CSigO (7)
CofEngrs (5)
CofT (5)
TSG (5)
AMC (5)
AMC Det No. 1 (Ord) (5)
USA CD Agcy (1)
USCONARC (5)
ARADCOM (2)
ARADCOM Rgn (2)
OS Maj Comd (3)
OS Base Comd (2)
LOGCOMD (2)
MDW (1)
Armies (2)
Corps (2)
USATC Armor (2)
USATC AD (2)
USATC Inf (2)
USATC Engrs (2)
USATC FA (2)
Instls (2) except
  Ft Monmouth (63)

USA Msl Comd (4)
Svc College (2)
Br Svc Sch (2) except
  USASCS (67)
GENDEP (OS) (2)
Sig Sec, GENDEP (OS) (5)
Army Dep (2) except
  Sacramento (17)
  Lexington (12)
  Tobyhanna (12)
  Ft Worth (8)
Sig Dep (OS) (12)
WRAMC (1)
Trans Tml Comd (1)
Army Tml (1)
POE (1)
OSA (1)
AMS (1)
Army Pic Cen (2)
USA Mob Spt Agcy (1)
Yuma Test Sta (2)
USA Carib Sig Agcy (1)
Sig Fld Maint Shop (3)
USA Elct Mat Agcy (25)
Chicago Proc Dist (1)

USA Elct RD Acty (Ft Huachuca) (2)
USA Elct RD Acty (White Sands, N Mex) (13)
USA Elct Comd (5)
USA Strat Comm Comd (4)
USA Corps (3)
JBUSMC (2)
Units organized under following TOE's (two copies each unless otherwise indicated):
  11–7
  11–16
  11–57
  11–97
  11–98
  11–117
  11–155
  11–157
  11–500 (AA–AE) (4)
  11–557
  11–587
  11–592
  11–597

NG: State AG (3).
USAR: None.
For explanation of abbreviations used, see AR 320-50.

U.S. GOVERNMENT PRINTING OFFICE: 1963 O—672510

TECHNICAL DATA

TECHNICAL MANUAL No. 11-2224

DEPARTMENT OF THE ARMY
WASHINGTON 25, D. C., *26 January 1956*

TELETYPEWRITER TEST SET TS-611A/FG

CHAPTER 1
INTRODUCTION

Section I. GENERAL

1. Scope

a. This technical manual contains information for the installation, operation, theory, maintenance, and repair of Teletypewriter Test Set TS–611A/FG (figs. 1 and 2).

b. Forward comments on this publication directly to Commanding Officer, The Signal Corps Publications Agency, Fort Monmouth, N. J., ATTN: Standards Division.

2. Forms and Records

The following forms will be used for reporting unsatisfactory conditions of Army equipment and in performing preventive maintenance:

a. DD Form 6, Report of Damaged or Improper Shipment, will be filled out and forwarded as prescribed in SR 745–45–5 (Army); Navy Shipping Guide, Article 1850–4 (Navy); and AFR 71–4A (Air Force).

b. DA Form 468, Unsatisfactory Equipment Report, will be filled out and forwarded to the Office of the Chief Signal Officer, as prescribed in SR 700–45–5.

c. DA Form 11–238, Operator First Echelon Maintenance Check List for Signal Corps Equipment (Radio Communication, Direction Finding, Carrier, Radar) will be prepared in accordance with instructions on the back of the form.

d. DA Form 11–239, Second and Third Echelon Maintenance Check List for Signal Corps Equipment (Radio Communication, Direction Finding, Carrier, Radar) will be prepared in accordance with instructions on the back of the form.

e. Use other forms and records as authorized.

Section II. DESCRIPTION AND DATA

3. Purpose and Use

a. Purpose. Teletypewriter Test Set TS–611A/FG measures distortion of teletypewriter signals. It detects, and indicates on meters, the displacement of transitions (changes from space to mark or mark to space) from their proper places in the signal combination. These transitions are translated into voltages across a capacitor and then compared with an accurate reference voltage. The magnitude of the distortion is indicated as a percentage of the total signal length. The magnitude of the average distortion is indicated on the BIAS meter. The magnitude of the largest single distortion is indicated on the TOTAL DIST meter.

b. Use. Teletypewriter Test Set TS–611A/FG may be used with the following types of teletypewriter circuits:

(1) Circuits operating at speeds of 60, 66, 75, or 100 words per minute (wpm).

(2) Circuits arranged for use with either the 5- or 6-unit selective code system.

(3) Circuits arranged for either 20- or 60-milliampere (ma) neutral operation or 30-ma polar operation.

Note. Throughout this manual, the term "teletypewriter test set" refers to Teletypewriter Test Set TS–611A/FG.

4. Application

a. The teletypewriter test set is used to test circuits that transmit a dc teletypewriter signal (par. 3*b*). It may be patched to the direct-current (dc) local loop circuit at the teletypewriter (A, fig. 3) or at any point in the dc

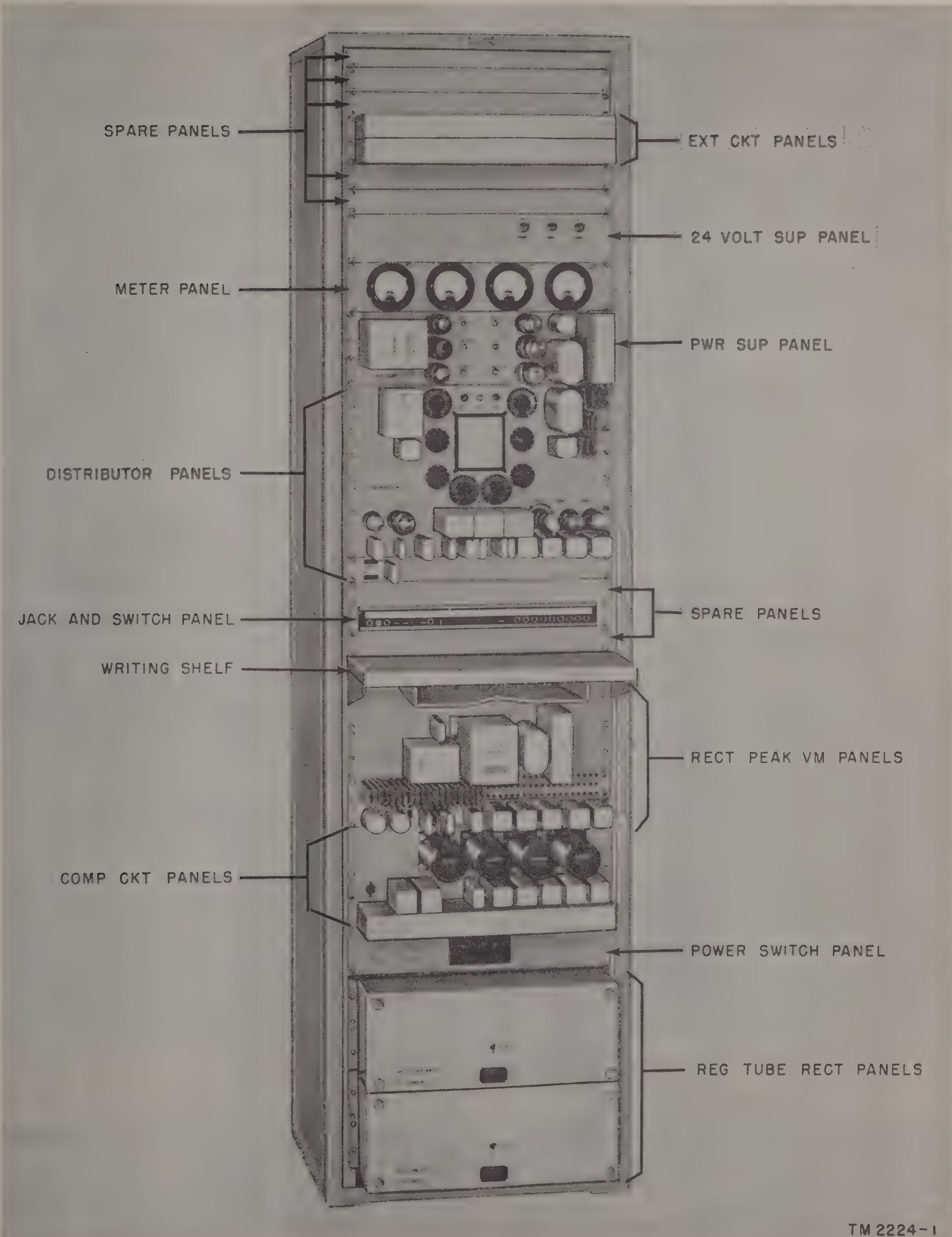


Figure 1. Teletypewriter Test Set TS-611A/FG, front view.

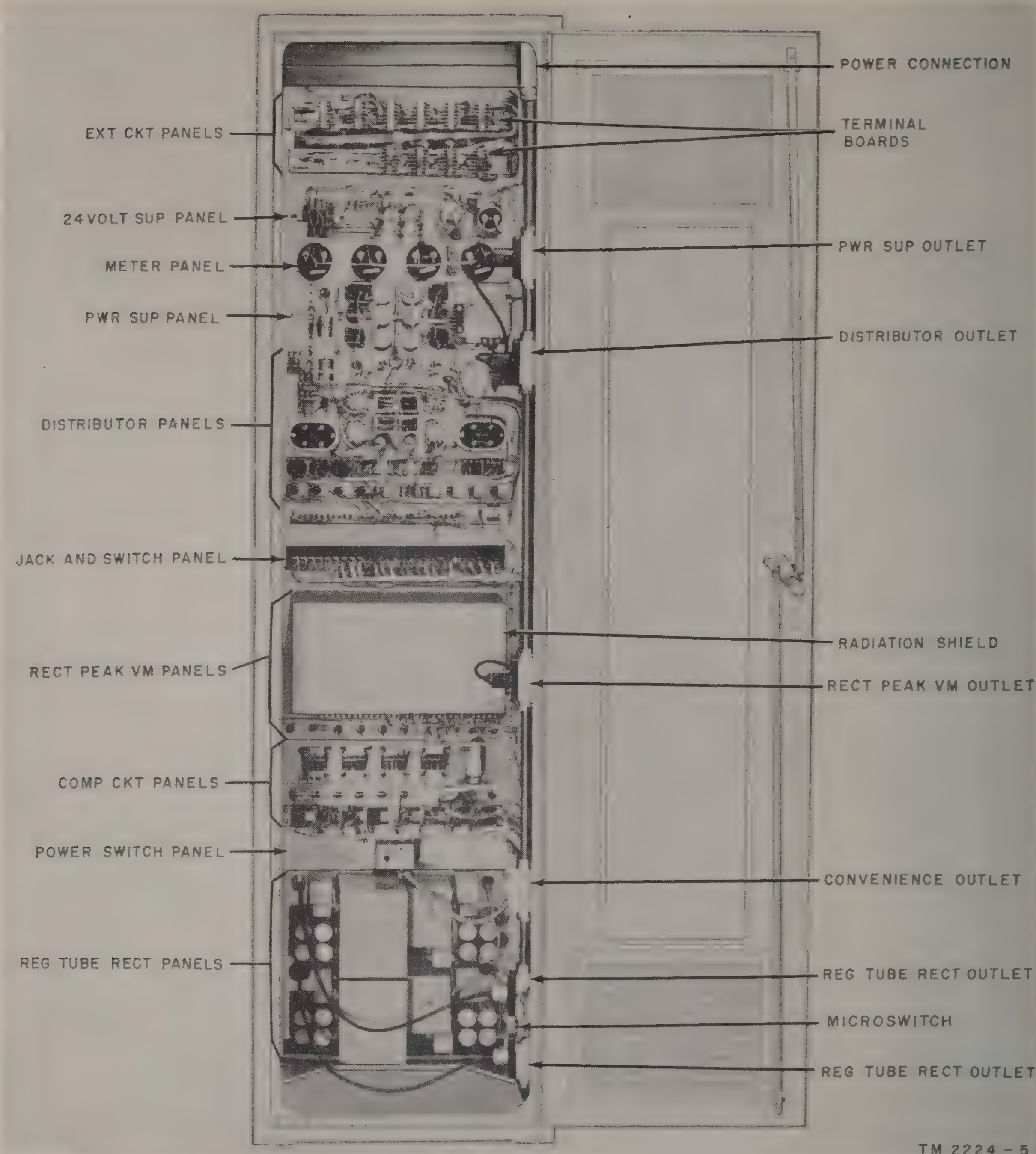
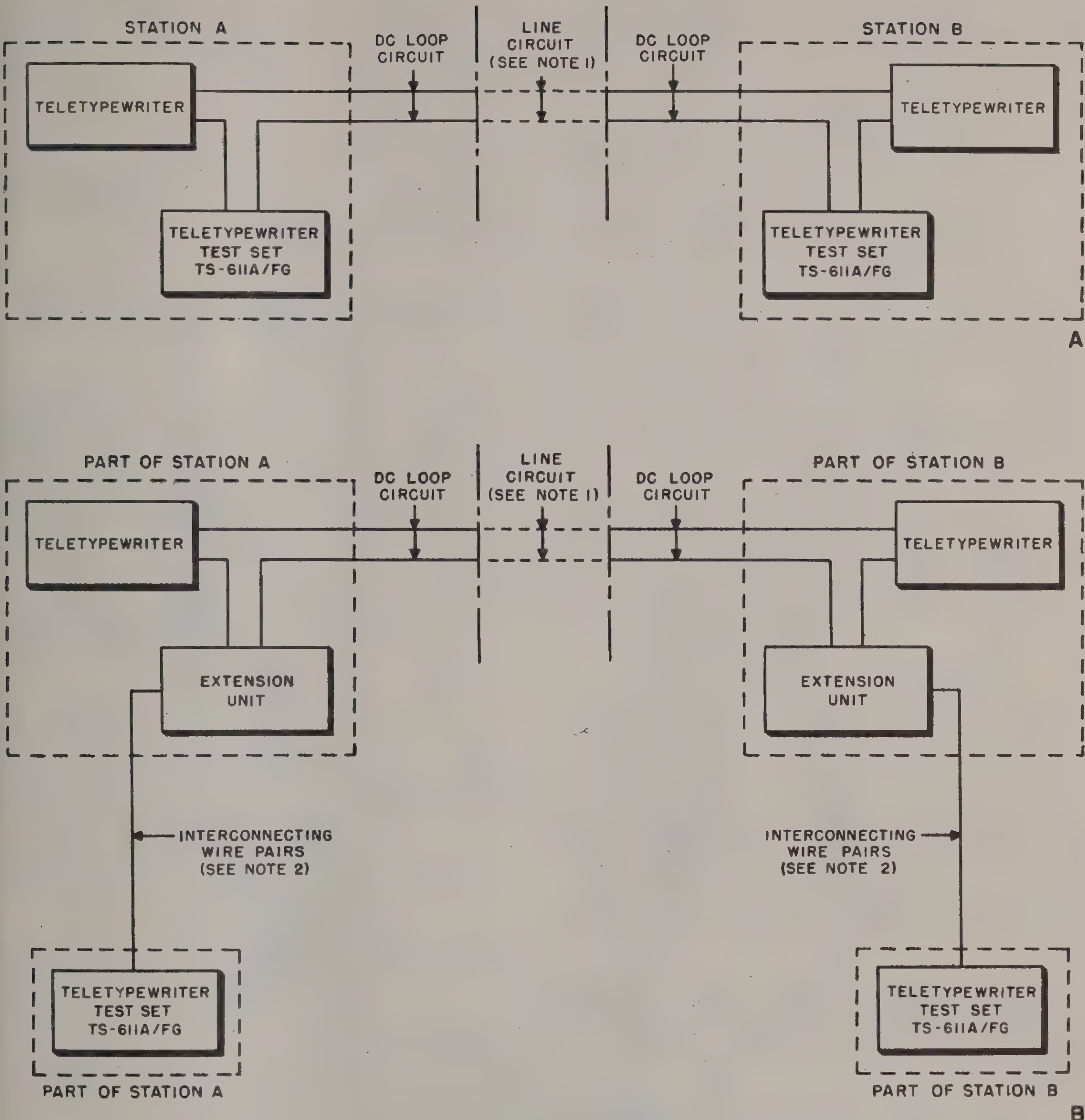


Figure 2. Teletypewriter Test Set TS–611A/FG, rear view.

circuit that contains a test appearance. The test appearance may be at test boards, patch boards, dc repeaters, or at loop circuits of voice-frequency equipment.

b. Extension units may be used with the teletypewriter test set. A maximum of 15 extension units may be used with *each* teletypewriter test set. These extension units permit the testing of teletypewriter circuits, which have test appearances at test boards or patch boards that are not in the vicinity of the teletypewriter test set. An extension unit may be located at a distance of 3,000 feet from the teletypewriter test set (B, fig. 3).



NOTES:

1. THE LINE CIRCUIT MAY BE A METALLIC, SIMPLEX, COMPOSITE, VOICE—FREQUENCY, OR SPEECH-PLUS-DUPLEX ARRANGEMENT.
2. THE DISTANCE BETWEEN THE TELETYPEWRITER TEST SET AND THE EXTENSION UNIT IS DEPENDENT UPON THE GAGE OF THE INTERCONNECTING PAIRS USED. MAXIMUM DISTANCE WITH 16 GAGE WIRE IS APPROXIMATELY 3,000 FEET.

TM 2224-2

Figure 3. Typical applications of teletypewriter test sets and extension units.

5. Technical Characteristics

a. Adaptability. Teletypewriter Test Set TS–611A/FG may be adapted for measuring signal distortion on the following types of teletypewriter circuits:

(1) Circuits operating at speeds of 60, 66, 75, or 100 wpm.

(2) Circuits arranged for use with either the 5 or 6 unit selective code system.

(3) Circuits arranged for either 20-ma or 60-ma neutral operation or 30-ma polar operation.

b. Extension Units. Teletypewriter Test Set TA–611A/FG is wired and equipped with relays for use with seven extension units. It is wired, but not equipped with relays, for use with a maximum of 15 extension units. Only five extension units are initially provided with Teletypewriter Test Set TS–611A/FG.

c. Power Requirements. The input voltage requirement for Teletypewriter Test Set TS–611A/FG is 105 to 125 volts alternating-current (ac), 60 cycles per second (cps), and the approximate power consumption is 460 watts.

6. Packaging Data
(fig. 4)

Teletypewriter Test Set TS–611A/FG and six cartons that contain spare parts and five extension units are packed in a nailed, steel-banded, wooden shipping crate. The crate is 106 inches high, 31 inches wide, and 29 inches deep. The volume of the crate is 55.1 cubic feet. The total weight is approximately 755 pounds. Packaging details are described in *a* through *d* below.

a. The teletypewriter test set is wrapped with a corrugated fiberboard cushion, placed on its side on a wooden mounting base, and fastened securely to the mounting base with steel bands.

b. Six cartons, containing spare parts and extension units, are placed on the side of the teletypewriter test set (side opposite the mounting base) and fastened securely in position.

c. The mounting base, teletypewriter test set, and six cartons are wrapped in corrugated fiberboard, a moisture-vaporproof barrier, and a waterproof barrier.

d. The proper amount of desiccant is added, the barriers are sealed, and the air is removed.

7. Table of Components

Component	Required No.	Dimensions (in.) Height	Width	Depth	Weight (lb)
Teletypewriter test set	1	84	22	17	625
Extension unit spare parts (par. 10).	[1]15	9½	4	4	5

[1]Only five extension units are supplied with the test set initially.

Note. This list is for general information only. See appropriate supply publications for information pertaining to requisition of spare parts.

8. Description of Teletypewriter Test Set TS–611A/FG
(figs. 1 and 2)

Teletypewriter Test Set TS–611A/FG is contained in a metal cabinet that is approximately 84 inches high, 22 inches wide, and 17 inches deep. The approximate weight is 625 pounds. The components of the teletypewriter test set are mounted on panels. A general description of each panel of the teletypewriter test set is provided in *a* through *m* below:

a. Spare Panels. Spare panel space is provided for mounting additional equipment when required.

b. EXT CKT Panels. Relays for seven extension relay circuits are mounted on two panels. Ten terminal boards, which are used to terminate extension unit wiring, are mounted on the rear side of the two panels. These terminal boards contain wiring terminations for 16 additional relays, which may be installed when the teletypewriter test set is adapted for use with 15 extension units.

c. 24 VOLT SUP Panel. Fuses for the outputs of the 24-volt dc supply, the —130-volt dc supply, and the +130-volt dc supply are located on this panel. One 2-ampere fuse (24V 2 AMP) is provided for the 24-volt dc supply circuit. Two 1-ampere fuses (—130V 1 AMP and +130V 1 AMP) are provided for the 130-volt dc supplies. The fuses are removable from the front side of the equipment.

d. Meter Panel. Four meters are mounted on the meter panel. They are marked BIAS, TOTAL DIST, CONST CUR, and SC-REF VOLT.

e. PWR SUP Panel. The PWR SUP panel contains the potentiometers and parts for the constant current, stop compensating voltage,

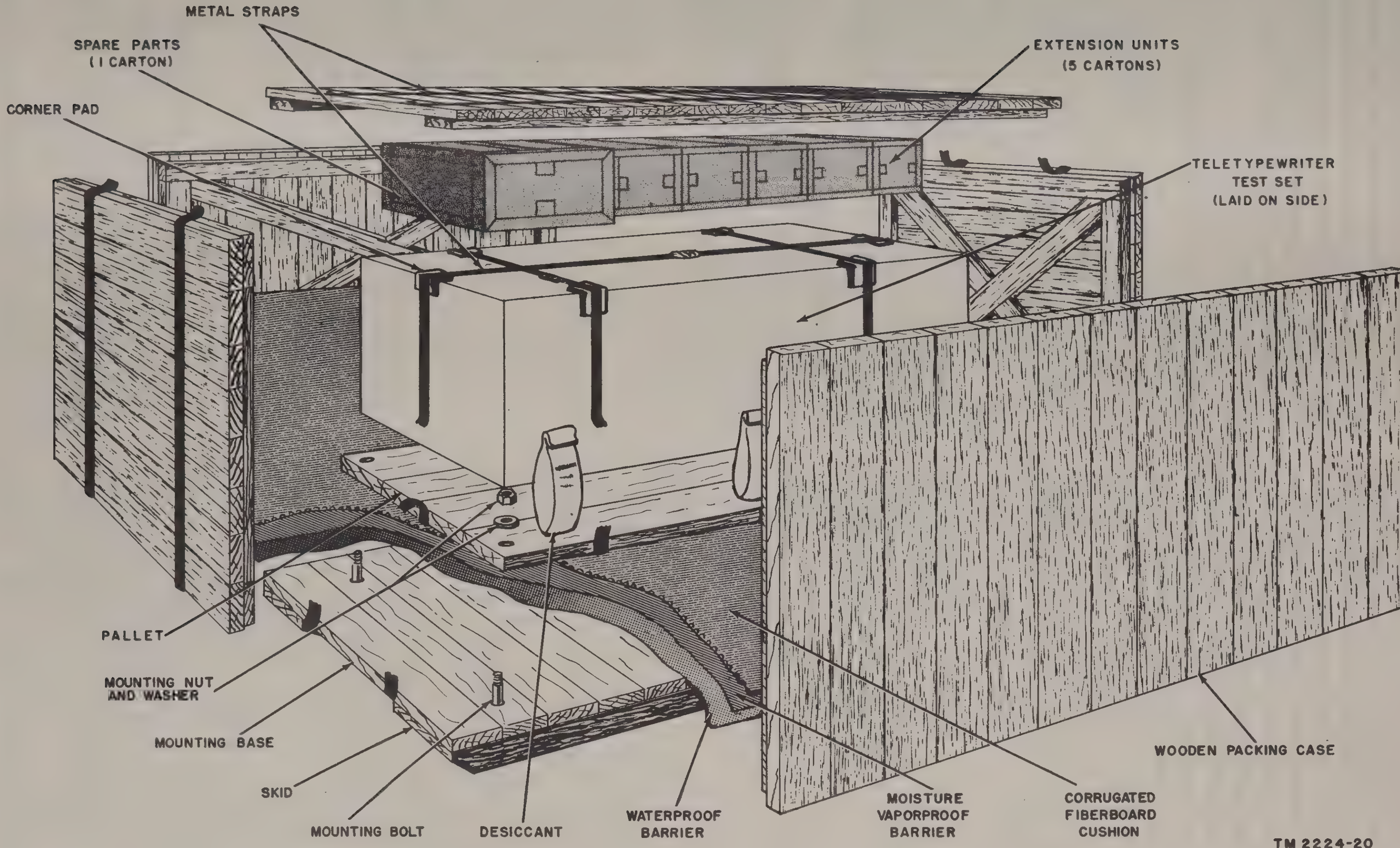


Figure 4. Typical packaging diagram.

and reference voltage circuits. The potentiometers are marked BIAS, AMP ADJ, ZERO ADJ, REF VOLT, SC VOLT, and CONST CUR.

f. DISTRIBUTOR Panels. The DISTRIBUTOR panels contain the parts, switches, and potentiometers for an electronic distributor circuit. They are used to adapt the teletypewriter test set for use with various types of teletypewriter circuit operation. The potentiometers and selector switches on the left side of the distributor panel are used to adapt the teletypewriter test set for operation at speeds of 75 or 100 wpm; those on the right side, for speeds of 60 or 66 wpm. The switches are marked FINE, COARSE, SPEED, and CODE. The potentiometers are marked ORIENT, DECR, and CHAR.

g. Jack and Switch Panel. The jack and switch panel contains 12 jacks, 12 switches, and 1 lamp. The jacks are used for monitoring connections, for input connections of circuits under test, and to provide appearances for test signal sources and working teletypewriter circuits. The switches are used to adapt the teletypewriter test set for use with various types of teletypewriter circuit operation. The lamp provides supervision.

h. RECT. PEAK VM Panels. The RECT PEAK VM panels contain the rectifying peak voltmeter circuit. The rear of one panel is covered with a radiation shield, which must be kept in place during operation of the teletypewriter test set.

i. COMP CKT Panels. The COMP CKT panels contain the comparison circuit. The polar relays on the COMP CKT panels are of the plug-in type.

j. POWER SWITCH PANEL. The POWER SWITCH PANEL contains the main power switch for the teletypewriter test set. The positions of the switch are marked ON and OFF.

k. REG TUBE RECT +TG Panel. The REG TUBE RECT +TG panel contains the +130-volt dc power supply circuit.

l. REG TUBE RECT —TG Panel. The REG TUBE RECT —TG panel contains the —130-volt dc power supply circuit.

m. Power Connection Assembly. The power connection assembly contains the ac supply circuit for the teletypewriter test set. The power connection assembly consists of a microswitch and six outlets. The microswitch disconnects all power from the teletypewriter test set when the rear door is opened. One outlet is intended for use as a convenience outlet for a connection to an extension light and/or a soldering iron. The remaining outlets are used to provide the input power connections for the PWR SUP, DISTRIBUTOR, RECT PEAK VM, and both REG TUBE RECT panels.

9. Description of Extension Unit
(fig. 10)

The extension unit is contained in a metal box that is approximately 9½ inches high, 4 inches wide, and 4 inches deep. The approximate weight is 5 pounds. Two meters (BIAS and TOT DIST), one jack, four switches, and two lamps are mounted on the front panel of the extension unit. The bottom edge of the front panel is hinged and can be pulled forward and down to provide access to the terminal boards that are used for connections between the extension unit and the teletypewriter test set.

10. Running Spares

The chart below contains a list of the running spares that are supplied with Teletypewriter Test Set TS–611A/FG. The spare parts are contained in a separate carton in the shipping crate.

Quantity	Item
1	Electron tube, type 2A5.
1	Electron tube, type 6F8G.
1	Electron tube, type 6H6.
1	Electron tube, type 6Y6G.
1	Electron tube, type 80.
1	Electron tube, type OD3/VR–150.
1	Electron tube, type 338A.
1	Electron tube, type OC3/VR–105.
1	Electron tube, type 5T4.
2	Electron tube, type 56.
2	Electron tube, type 394A.
1	Polar relay, type 255A.
1	Mercury relay, type 275C.
1	Thermal relay.

11. Additional Equipment Required

The wires, cables, patch cords, and test equipment described in *a* through *f* below are not supplied as part of Teletypewriter Test Set TS–611A/FG but are required for its installation and operation.

a. Shielded two-conductor cable is required

for connection of the meter circuits of the extension units to the meter circuits of the teletypewriter test set (par. 18*d*).

b. Eight-pair cable (#20 AWG) is required for the connection of the extension units to the extension relay circuits of the teletypewriter test set.

c. A copper-wire pair (#12 AWG) is required for the connection of the teletypewriter test set to a 105- to 125-volt, 60-cps external power source.

d. A bare copper wire (#6 AWG) is required for the connection of the teletypewriter test set to the central office ground.

e. A 4- to 6-foot long patch cord with a plug (PL–055 or PL–347) on each end is required for the connection of the teletypewriter test set to test signal sources and to the teletypewriter line or loop circuits.

f. Multimeter TS–297/U.

CHAPTER 2
INSTALLATION

Section I. SERVICE UPON RECEIPT OF EQUIPMENT

12. Siting

Locate Teletypewriter Test Set TS–611A/FG near telegraph test boards or telegraph patch boards in central office.

a. The teletypewriter test set is designed for use in a sheltered room at normal temperatures (68° to 72°F.). The shelter for the teletypewriter test set must meet the following requirements:

(1) The floor must be capable of supporting the weight of the teletypewriter test set in a level position without vibration.

(2) There must be sufficient space behind and in front of the teletypewriter test set to permit inspection, maintenance, and operation.

(3) The teletypewriter test set must be placed where normal air circulation is not hindered.

(4) A 105- to 125-volt ac, 60 cps, power source must be available.

(5) There must be adequate lighting.

b. The extension unit should be located close enough to a telegraph test board or a telegraph patch board so that the patch cords on these boards can be used for connection to the extension unit.

13. Uncrating, Unpacking, and Checking New Equipment

Note. For used or reconditioned equipment, refer to paragraph 17. When new equipment is received, select a location where the equipment may be unpacked without exposure to the elements and which is convenient to the installation of the equipment. Be careful when unpacking or handling the equipment; it may become damaged easily when it it not protected by the packing case.

a. Uncrating.

(1) Place the packing case near the operating location and so that the side marked *top* is up. In this position, the teletypewriter test set is resting on its side.

(2) Cut the outside steel straps. Use a nail puller to remove the nails along the lower edge of the case. Do not pry the cover from the skid; this could result in damage to the inclosed equipment.

(3) Lift the top of the packing case from the skid, slit the waterproof liner, and cut the moisture-vaporproof metal foil barrier along its top seams.

(4) Inside the moisture-vaporproof barrier is a wrapping of heavy, corrugated fiberboard around the teletypewriter test set. Slit the tape that holds this wrapping in place and cut the steel straps that hold the teletypewriter test set on the mounting base.

(5) Remove the side panels of the packing case.

b. Unpacking. The spare parts and five extension units are packed with the teletypewriter test set in the packing case. They are packed in six separate corrugated containers. Cut the tape on the corrugated containers and remove the contents.

c. Checking. Check the quantities of the items against the packing slip and inspect the equipment for any physical damage that might have occurred during shipment.

14. Installation of Teletypewriter Test Set

Install the teletypewriter test set so that the front panel is in line with the front panels of other equipments. Securely fasten the teletypewriter test set to the floor as described below.

a. Wood Floor. If the floor is made of wood, drill four holes (1/4 in. diameter) in the floor (fig. 5). Move the teletypewriter test set into position. Place lag screws (with washers) in the four holes at the bottom of the teletypewriter test set and screw them into the floor.

b. Concrete Floor. If the floor is concrete, drill four holes (7/8 in. in diameter and 2 1/2 in. deep) in the floor (fig. 5). Insert lead shields in the holes. Move the teletypewriter test set into position. Place lag screws (with washers) in the four holes at the bottom of the teletypewriter test set and screw them into the lead shields.

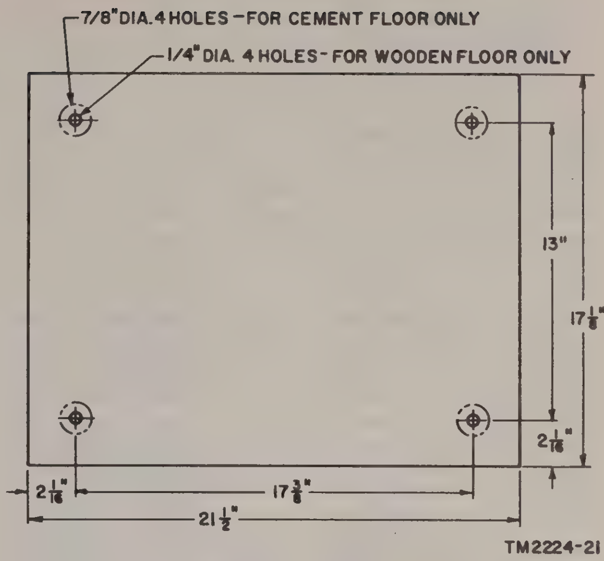


Figure 5. Template for drilling holes in floors.

15. Installation of Extension Unit

Install the extension units on the uprights of a telegraph test board or a telegraph patch board. The extension unit may be installed on either side of the test or patch boards (right or left) but should be at a height of approximately 5 1/2 feet.

16. Installation of Fuses, Tubes, and Relays

Install the fuses, tubes, and relays in the teletypewriter test set (figs. 1 and 2). Use the charts provided in *a*, *b* and *c* below.

a. Fuses.

Caution: When installing or replacing fuses, do not use fuses that are rated above the specified values.

Reference symbol	Size (amp)	Panel	Location on panel
AC1	3	REG TUBE RECT +TG	Fuse holder under front cover.
AC2	3	REG TUBE RECT +TG	Fuse holder under front cover.
AC1	3	REG TUBE RECT −TG	Fuse holder under front cover.
AC2	3	REG TUBE RECT −TG	Fuse holder under front cover.
F601	2	24 VOLT SUP	24V fuse holder on front of panel.
F602	1	24 VOLT SUP	−130V fuse holder on front of panel.
F603	1	24 VOLT SUP	+130V fuse holder on front of panel.
	.8	PWR SUP	In ac plug on rear of panel (two fuses required).
	.5	DISTRIBUTOR	In ac plug on rear of panel (two fuses required).
	.5	RECT PEAK VM	In ac plug on rear of panel (two fuses required).

b. Tubes.

Reference symbol	Type	Panel	Location on panel
V101	OC3/VR–105	PWR SUP	Front of panel (fig. 13).
V102	5T4	PWR SUP	Front of panel (fig. 13).
V103	OC3/VR–105	PWR SUP	Front of panel (fig. 13).
V104	OD3/VR–150	PWR SUP	Front of panel (fig. 13).
V105	2A5	PWR SUP	Front of panel (fig. 13).
V106	6Y6G	PWR SUP	Front of panel (fig. 13).
V201	6H6	DISTRIBUTOR	Front of panel (fig. 11).
V202	6Y6G	DISTRIBUTOR	Front of panel (fig. 11).
V203	6F8G	DISTRIBUTOR	Front of panel (fig. 11).
V204	338A	DISTRIBUTOR	Front of panel (fig. 11).
V205	338A	DISTRIBUTOR	Front of panel (fig. 11).
V301	56	RECT PEAK VM	Rear of panel.
V302	56	RECT PEAK VM	Rear of panel.
V303	56	RECT PEAK VM	Rear of panel.
V304	80	RECT PEAK VM	Rear of panel.
V1	394A	REG TUBE RECT +TG	Under front cover.[1]
V2	394A	REG TUBE RECT +TG	Under front cover.[1]
V1	394A	REG TUBE RECT –TG	Under front cover.[1]
V2	394A	REG TUBE RECT –TG	Under front cover.[1]

[1]Place cap on top of tube.

c. Relays.

Caution: The 275C relay is hermetically sealed and is under great pressure. Do not drill into the relay. When disposing of it, do not throw the relay in a fire.

Reference symbol	Type	Panel	Location on panel
K1	Mercury 275C	COMP CKT	Rear of panel.
K2	Polar 255A	COMP CKT	Front of panel.
K3	Polar 255A	COMP CKT	Front of panel.
K4	Polar 255A	COMP CKT	Front of panel.
K5	Polar 255A	COMP CKT	Front of panel.
K2	Thermal	REG TUBE RECT +TG	Under front cover.
K2	Thermal	REG TUBE RECT –TG	Under front cover.

17. Service Upon Receipt of New or Reconditioned Equipment

a. Follow the instructions in paragraphs 12 and 13 for siting, uncrating, unpacking, and checking the equipment.

b. Check the equipment for tags or other indications pertaining to changes in equipment wiring. If any changes in wiring have been made, note the changes in this technical manual, preferably on the schematic and wiring diagrams.

c. Refer to paragraphs 14 through 16 for installation instructions and to paragraphs 18 through 25 for connection instructions.

Section II. CONNECTIONS

18. Connections Between Extension Units and Teletypewriter Test Set

Make the connections between each extension unit and the teletypewriter test set as indicated in *a* through *d* below. *If extension units are not used with the teletypewriter test set, make*

the connections as indicated in paragraph 19a.

a. Plan the connections between each extension unit and the teletypewriter test set using the information in A, figure 6.

b. For odd-numbered extension units (1, 3, 5, and so on), use the information in B, figure 6 to connect terminal boards TB701 and TB702 of the extension unit to the appropriate terminal board (A, fig. 6) of the teletypewriter test set.

c. For even-numbered extension units (2, 4, 6, and so on), use the information in C, figure 6 to connect terminal boards TB701 and TB702 of the extension unit to the appropriate terminal board (A, fig. 6) of the teletypewriter test set.

d. Connect the BIAS meter circuits and the TOT DIST meter circuits of each extension unit to the meter circuits of the teletypewriter test set using the information in figure 7. The total resistance of wires used to connect all BIAS meters should not exceed 25 ohms. This resistance limitation also applies to wires used to connect all TOT DIST meters. The gage of wire used is dependent upon this limitation.

e. Make additional strap connections (#20 AWG) following the procedures in paragraph 19*b*.

19. Wiring Options

a. Option W. Strap connections are required on terminal board TB1 and on relay K11 of the teletypewriter test set when extension units *are not used.* Make these connections as described in (1) through (3) below.

(1) Strap terminal 29 to terminal 30 on terminal board TB1 at the top rear of the test set (A, fig. 8).

(2) Strap terminal 31 to terminal 32 on terminal board TB1 at the top rear of the test set (A, fig. 8).

(3) Strap terminal 9B to tetrminal 13B on relay K11 at the rear of the COMP CKT panel (B, fig. 8).

b. Options X, Y, and Z. Strap connections are required on resistors R22 and R23 of the teletypewriter test set when the extension units *are used.* Make the connections at the rear of the meter panel using the information contained in the chart below and in C, figure 8.

Extension units (number used)	Connections required (option)
1 or 2	None.
3	X.
4 or 5	X and Y.
6, 7, or 8	Y and Z.
9 or more	X, Y, and Z.

Note. Strap connections for option W (*a* above) are normally wired at the factory. Remove these straps if extension units are used.

20. Connections for POL CAL Jacks

a. Polar test signals (60, 75, and 100 wpm) may be used for calibration of the teletypewriter test set. Test equipment necessary to produce the polar test signals is not included as part of the teletypewriter test set. External sources of 60, 75, and 100 wpm test signals (polar) may be permanently connected to the teletypewriter test set. POL CAL jacks (60, 75, and 100) are provided on the jack and switch panel for this purpose.

b. Connect external test-signal equipments to the POL CAL jacks using the information in A, figure 9. *If the test-signal equipment is used to provide test signals for jack appearances at different locations, connect the test-signal equipment to the jacks at each location using the information in B, figure 9.*

21. Connections for MISC TRKS Jacks

Six MISC TRKS jacks are mounted on the jack and switch panel of the teletypewriter test set to provide permanent jack appearances for six trunk circuits. Connect the trunk circuits to the MISC TRKS jacks using the information in figure 10.

22. Connections for Ground-Interrupter Equipment

a. The teletypewriter test set and the extension units contain all the wiring and parts necessary for supervisory signaling *except those required to supply a necessary source of interrupted ground.* If supervisory signaling is desired, an external source of interrupted ground can be connected to the teletypewriter test set by the installer. Ground-interrupter equipment must be capable of supplying interrupted ground to the teletypewriter test set at a rate of 60 interruptions per minute (ipm) and also at a rate of 120 ipm.

b. Connect the ground-interrupter equip-

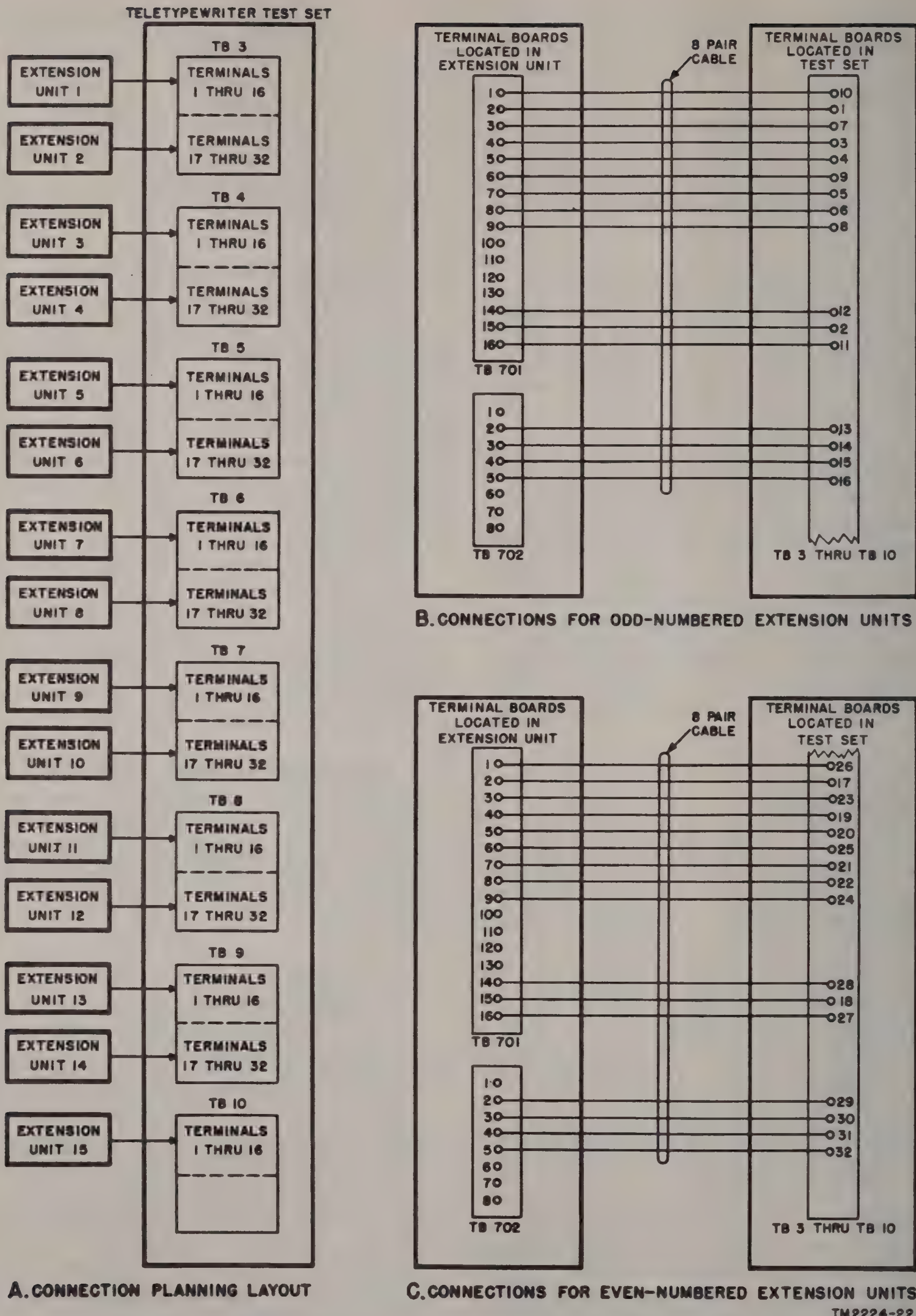


Figure 6. Connections between extension units and teletypewriter test set.

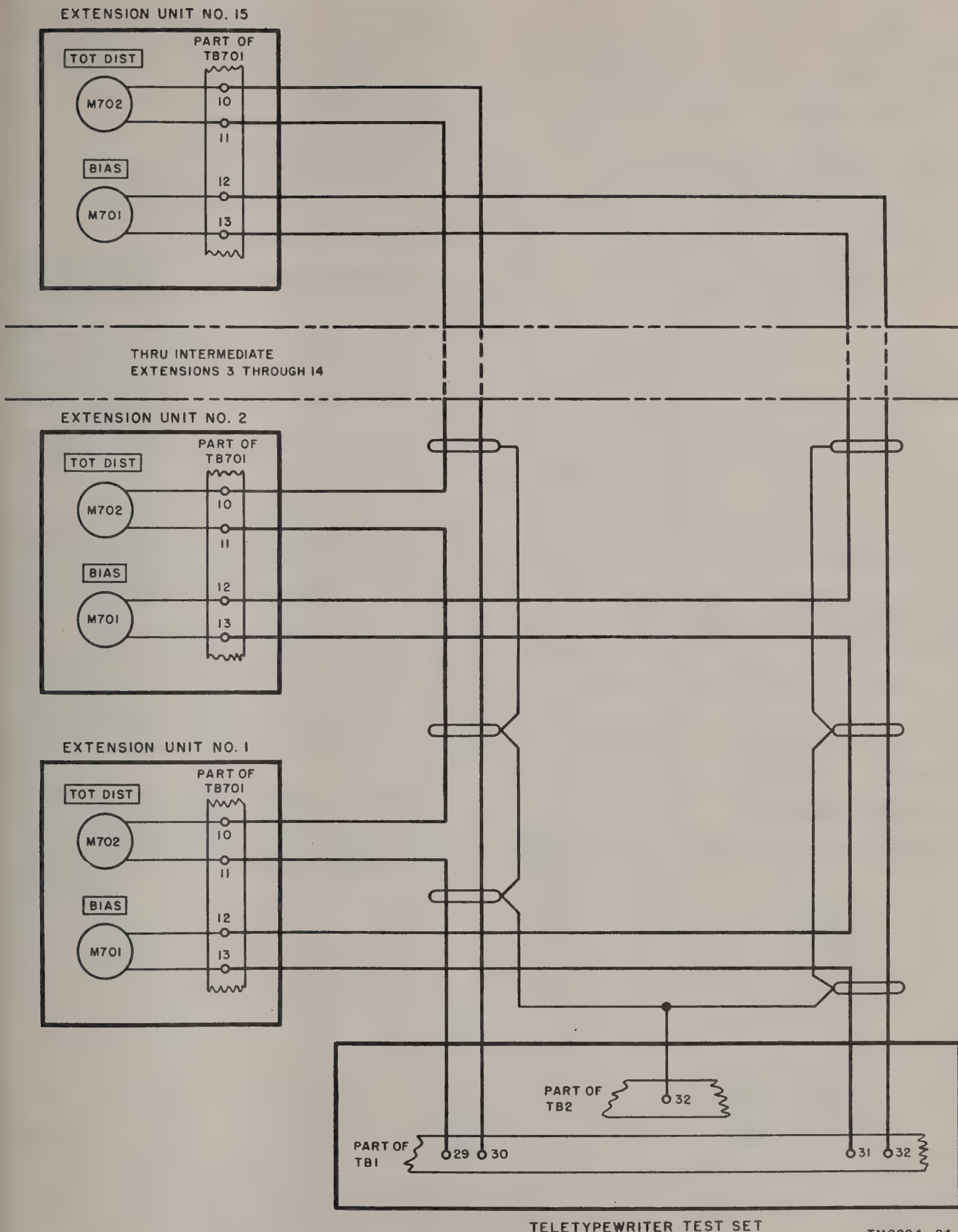


Figure 7. Connections for extension unit meter circuits.

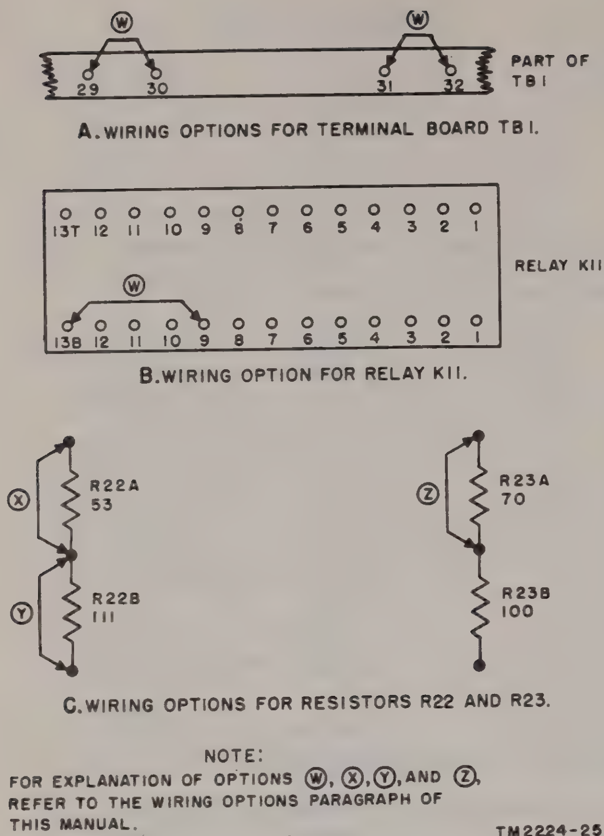


Figure 8. Connections for wiring options.

ment to the teletypewriter test set using the information in figure 11.

23. Panel Connections

Panel connections are made at the rear (right side) of the teletypewriter test set (fig. 2). Insert the power plug associated with each of the following panels into an outlet on the power connection assembly:

a. PWR SUP panel.
b. DISTRIBUTOR panel.
c. RECT PEAK VM panel.
d. REG TUBE RECT +TG panel.
e. REG TUBE RECT —TG panel.

24. Ground Connections

The ground connection is made at the top rear (right side) of the teletypewriter test set (fig. 2).

a. Solder one end of a copper wire (#6 AWG) to the ground terminal located on one of the mounting screws for the EXT CKT panel.

b. Connect the other end of the wire to the central office ground.

25. Power Connections

The power connections are made to the black and white wires located at the junction box on the top rear (right side) of the teletypewriter test set (fig. 2).

a. Splice and solder a piece of copper wire (#12 AWG) to the black wire and tape the splice. Connect the other end of the copper wire to the ungrounded side of a 105- to 125-volt, 60-cps, ac power source that is fused for 20 amperes.

b. Splice and solder another piece of copper wire (#12 AWG) to the white wire lead and tape the splice. Connect the other end of this wire to the grounded side of the power source.

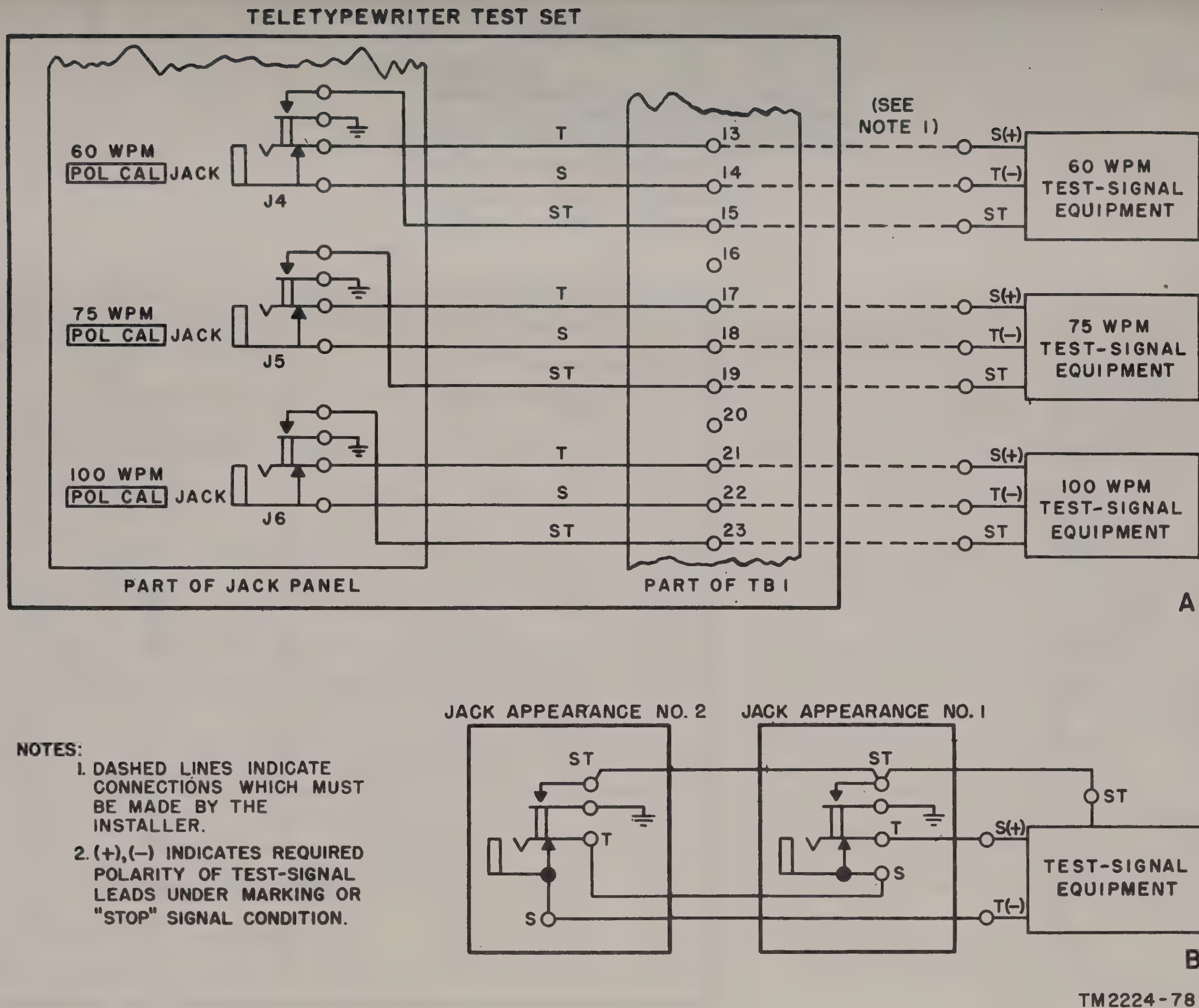
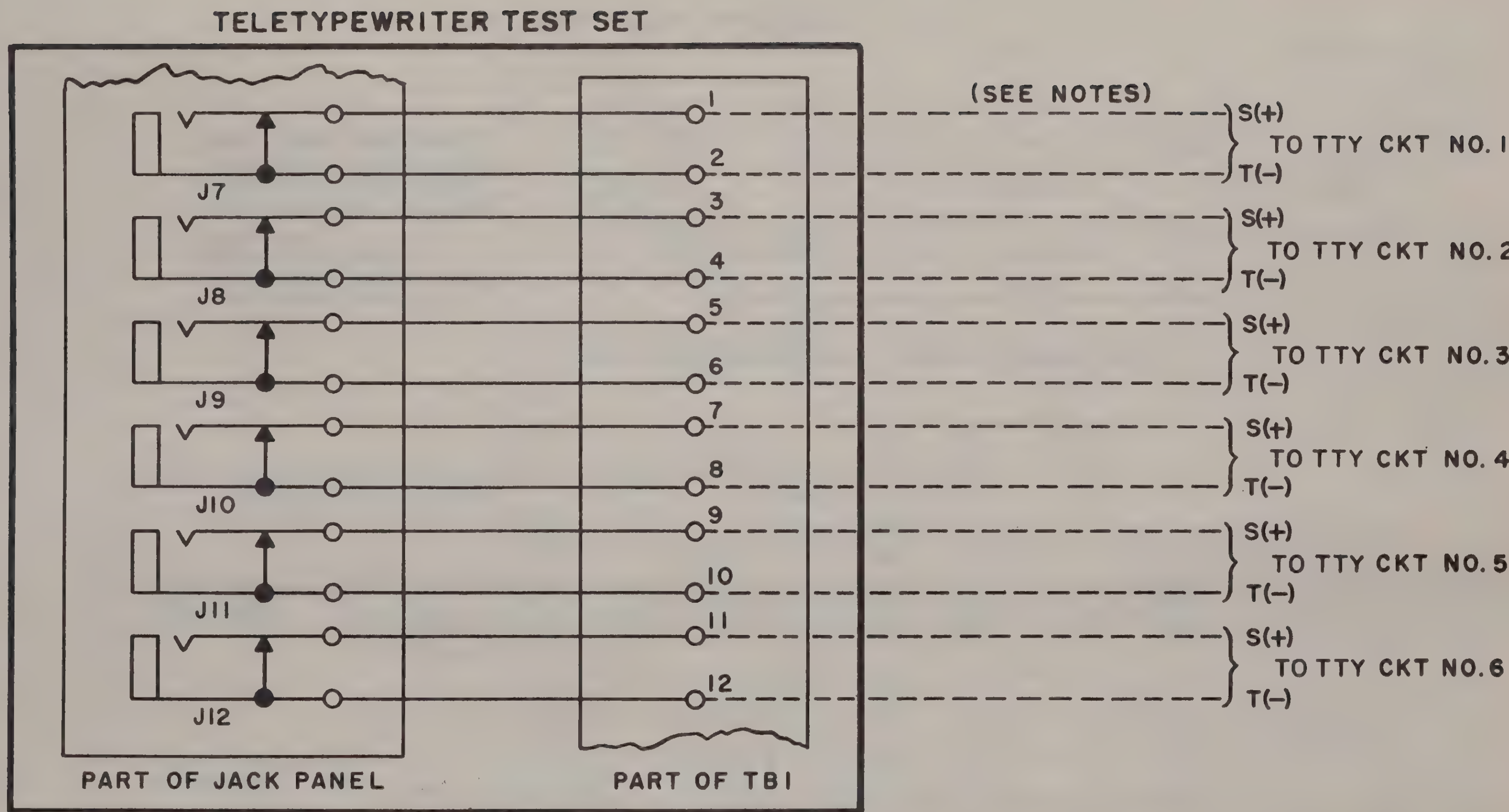


Figure 9. Connections for POL CAL jacks.



NOTES:

1. DASHED LINES INDICATE CONNECTIONS WHICH MUST BE MADE BY THE INSTALLER.
2. (+),(–) INDICATES REQUIRED POLARITY OF TELETYPEWRITER CIRCUIT LEADS UNDER MARKING OR "STOP" SIGNAL CONDITION.

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Figure 10. Connections for MISC TRKS jacks.

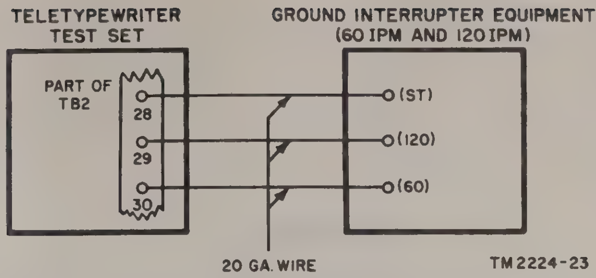

Figure 11. Connections for ground-interrupter equipment.

CHAPTER 3
OPERATION

Section I. CONTROLS AND INSTRUMENTS

26. General

Haphazard or improper setting of controls or use of jacks will result in improper operation or incorrect test conditions. Improper use of meter readings or lamp indications will result in incorrect test interpretations. For these reasons, it is important to know the function of the controls and instruments of the teletypewriter test set (par. 27) and the extension units (par. 28) before making preliminary operating adjustments (pars. 29–34) or before operating the equipment (par. 35–41).

27. Teletypewriter Test Set

The location of the controls and instruments on the teletypewriter test set and description of their functions is given in *a* through *g* below.

a. Meter Panel (fig. 12).

Instrument	Function
BIAS meter	Indicates the magnitude of the average bias distortion (marking or spacing), for teletypewriter signals under test, in percent of a unit signal element length. Also provides indications for adjustments made when the teletypewriter test set is being prepared for operation.
TOTAL DIST meter	Indicates the combined effects of bias, characteristic, and fortuitous distortion, for teletypewriter signals under test, in percent of a unit signal element length. Also provides indications for adjustments made when the teletypewriter test set is being prepared for operation.
CONST CUR meter	Indicates the magnitude of the constant current supply when adjustments are being made to prepare the teletypewriter test set for operation.
SC-REF VOLT meter	Indicates the magnitude of the stop compensating voltage and the reference voltage when adjustments are being made to prepare the teletypewriter test set for operation.

b. PWR SUP Panel (fig. 13).

Control (potentiometer)	Function
BIAS	Adjusts the calibration of the BIAS meter so that it will indicate the magnitude of the bias distortion present in teletypewriter signals under test.
REF VOLT	Adjusts the magnitude of the reference voltage supply, to its proper value.
AMP ADJ	Adjusts the calibration of the TOTAL DIST meter so that it will indicate the magnitude of the total distortion present in teletypewriter signals under test.
SC VOLT	Adjusts the magnitude of the stop compensating voltage supply, to its proper value.
ZERO ADJ	Adjusts the zero reading of the TOTAL DIST meter.
CONST CUR	Adjusts the constant current supply to its proper value.

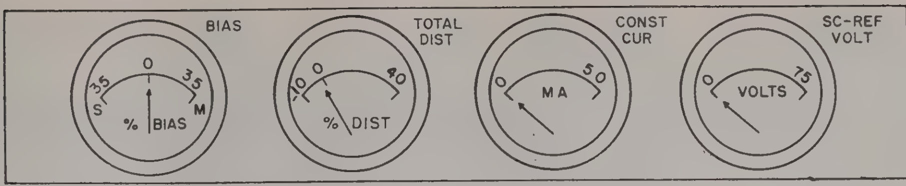

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Figure 12. Meter panel, front view.

c. *DISTRIBUTOR Panel* (fig. 14).

Control	Function
SPEED switch	Switch position 75 arranges the teletypewriter test set for operation with 75-wpm teletypewriter circuits. Switch position 100 arranges the teletypewriter test set for operation with 100-wpm teletypewriter circuits. Functions only when the CHG SPD switch is operated.
CHAR potentiometer	Controls the time interval that the distributor circuit will require to complete its operation for one teletypewriter character. Requires only one adjustment for all teletypewriter speeds.
CODE switch	Switch position 5 arranges the teletypewriter test set for testing teletypewriter signals that contain five intelligence elements for each character. Switch position 6 arranges the teletypewriter test set for testing teletypewriter signals that contain six intelligence elements for each character.
ORIENT potentiometers	The ORIENT potentiometer on the left-hand side of the panel controls the timing of the grounding intervals for the measuring capacitors (relative to the start pulse transition) when 75- or 100-wpm circuits are being tested. The ORIENT potentiometer on the right-hand side of the panel controls the timing of the grounding intervals for the measuring capacitors (relative to the start pulse transition) when 60-wpm circuits are being tested.
FINE switches	The FINE switch on the left-hand side of the panel provides a *fine* adjustment of the oscillator frequency, that controls the timing of the grounding intervals for the measuring capacitors, when 75- or 100-wpm circuits are being tested. The FINE switch on the right-hand side of the panel provides a *fine* adjustment of the oscillator frequency, that controls the timing of the grounding intervals for the measuring capacitors, when 60-wpm c rcuits are being tested.
COARSE switches	The COARSE switch on the left-hand side of the panel provides a *coarse* adjustment of the oscillator frequency, that controls the timing of the grounding intervals for the measuring capacitors, when 75- or 100-wpm circuits are being tested. The COARSE switch on the right-hand side of the panel provides a *coarse* adjustment of the oscillator frequency, that controls the timing of the grounding intervals for the measuring capacitors, when 60-wpm circuits are being tested.
DECR potentiometers	The DECR potentiometer on the left-hand side of the panel controls the amplitude of the oscillator voltage, that controls the timing of the grounding intervals for the measuring capacitors, when 75- or 100-wpm circuits are being tested. The DECR potentiometer on the right-hand side of the panel controls the amplitude of the oscillator voltage, that controls the timing of the grounding intervals for the measuring capacitors, when 60-wpm circuits are being tested.

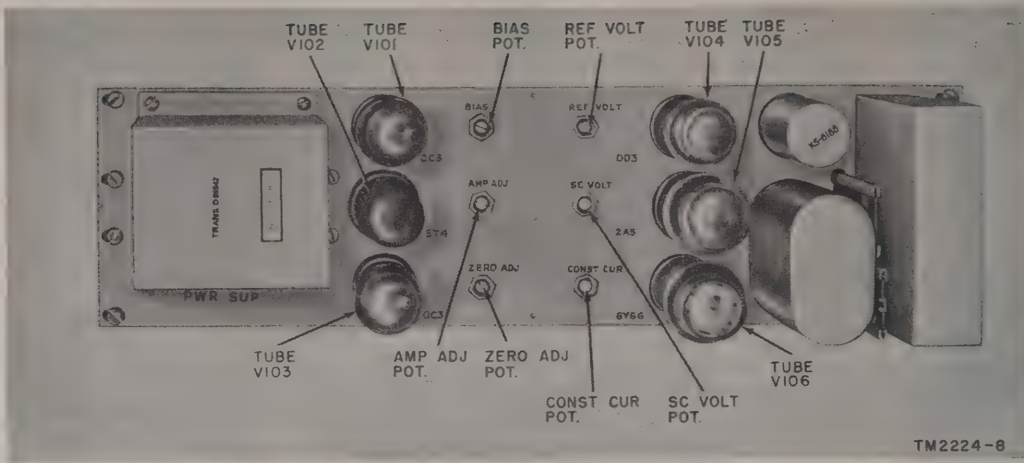


Figure 13. PWR SUP panel, front view.

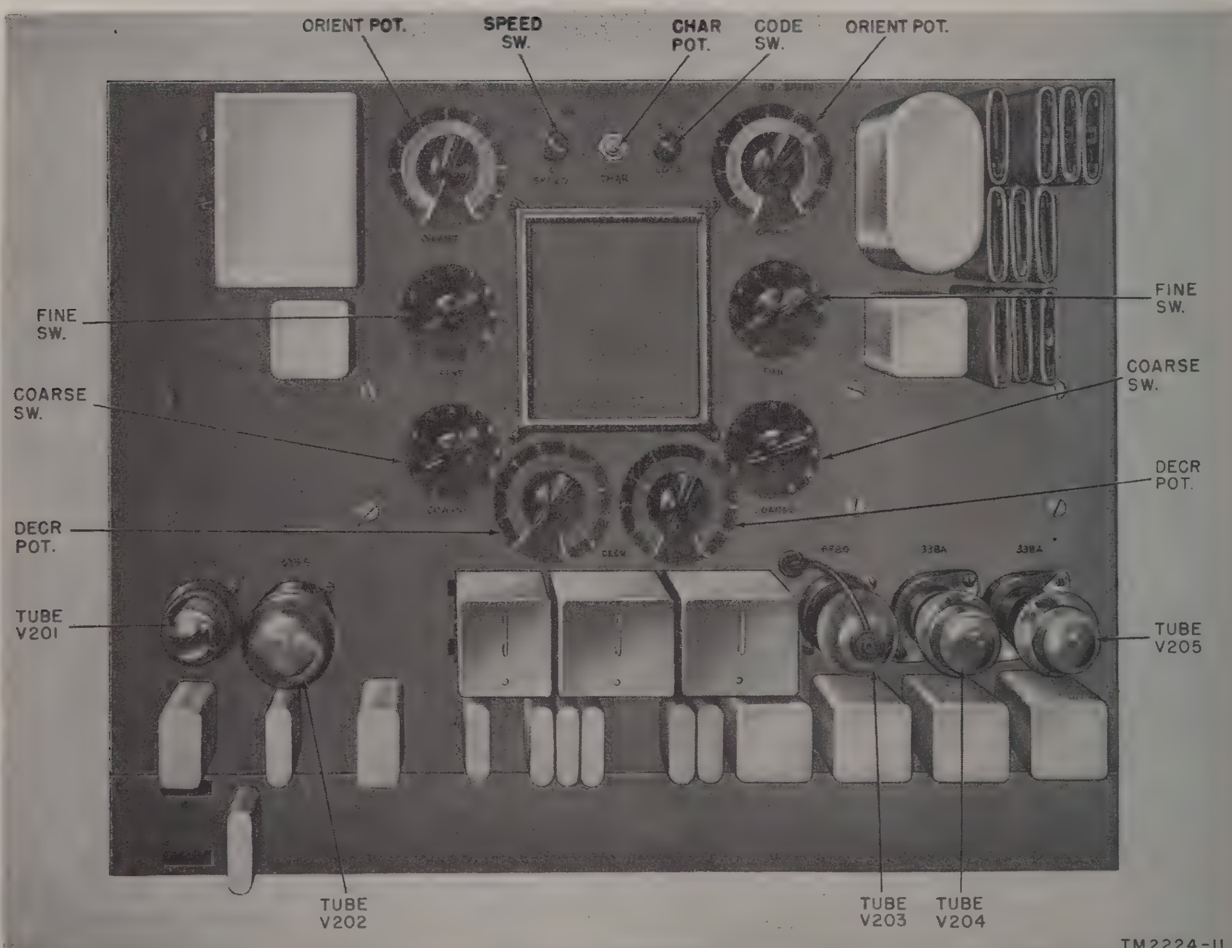


Figure 14. DISTRIBUTOR panel, front view.

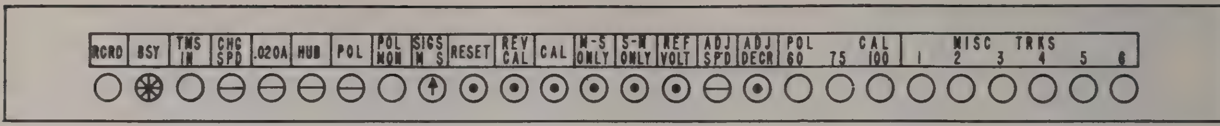
d. Jack and Switch Panel (fig. 15).

Control	Function
RCRD jack	For connecting a recorder to the teletypewriter test set.
BSY lamp	Indicates whether the teletypewriter test set is idle, busy, or calibrated for the wrong speed.
TMS IN jack	Used to connect the circuit to be tested to the teletypewriter test set.
CHG SPD switch	In nonoperated position (horizontal), arranges the teletypewriter test set for operation with 60-wpm circuits. In operated position (vertical), arranges the teletypewriter test set for operation with 75- or 100-wpm circuits.
.020A switch	In nonoperated position (horizontal), arranges the teletypewriter test set for operation with 60-ma neutral circuits. In operated position (vertical), arranges the teletypewriter test set for operation with 20-ma neutral circuits.
POL switch	In nonoperated position (horizontal), arranges the teletypewriter test set for operation with neutral circuits. In operated position (vertical), arranges the teletypewriter test set for operation with polar circuits.
POL MON jack	For monitoring current values of polar signals at the armature of relay K2 with a 75–0–75 ma meter.
SIGS switch	In M position, operates the armatures of transition relays K4 and K5 to their mark contacts. In S position, operates the armatures of transition relays K4 and K5 to their space contacts. Switch is effective only when a plug is inserted into the TMS IN jack at the teletypewriter test set.
RESET switch	When operated, rapidly restores the TOTAL DIST meter indications to the zero position.
CAL switch	When operated, introduces a 15 percent spacing bias in the BIAS and TOTAL DIST meter circuits and permits their calibration by adjustment of the BIAS and AMP ADJ potentiometers, respectively.
REV CAL switch	When operated, reverse the current in the rectifying peak voltmeter circuit.
M-S ONLY switch	When operated, arranges the circuits in the teletypewriter test set so that only mark-to-space transitions are applied to the measuring capacitors.
S-M ONLY switch	When operated, arranges the circuits in the teletypewriter test set so that only space-to-mark transitions are applied to the measuring capacitors.
REF VOLT switch	When operated, arranges the circuits in the teletypewriter test set so that the reference voltage supply circuit is connected to the SC–REF VOLT meter.
ADJ SPD switch	When operated, arranges the teletypewriter test set for adjusting the speed of its distributor circuit.
ADJ DECR switch	When operated, arranges the teletypewriter test set for adjusting the magnitude of the oscillator voltage.
POL CAL jacks	Jack 60 provides an appearance on the teletypewriter test set for a 60-wpm polar test signal. Jack 75 provides an appearance on the teletypewriter test set for a 75-wpm polar test signal. Jack 100 provides an appearance on the teletypewriter test set for a 100-wpm polar test signal.
MISC TRKS jacks	Jacks 1, 2, 3, 4, 5, and 6 provide test appearances on the teletypewriter test set for permanent connections to any six trunk circuits.

e. POWER SWITCH PANEL. One two-position switch is located on the POWER SWITCH PANEL (fig. 1). When the switch is operated to the OFF position, the 115-volt ac power source is disconnected from all the outlets at the rear of the teletypewriter test set except the convenience outlet for the extension light and/or soldering iron (fig. 2). When the switch is operated to the ON position, the ac power source is connected to all of the outlets at the rear of the teletypewriter test set.

f. REG TUBE RECT Panels. Two controls are provided on each REG TUBE RECT panel (fig. 1).

(1) *Potentiometer R.* A potentiometer is located approximately in the center of each REG TUBE RECT panel. On the top REG TUBE RECT panel, the



NOTES:
1. HUB SWITCH NOT PROVIDED.
2. ON THIS DRAWING ONLY, JACK, LAMP AND SWITCH SYMBOLS ARE DEFINED AS FOLLOWS:

JACK
LAMP
TWO-POSITION SWITCH
THREE-POSITION SWITCH
PUSH-BUTTON SWITCH

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Figure 15. Jack and switch panel, front view.

potentiometer is marked +TG and is used to adjust the output for +130 volts dc. On the bottom REG TUBE RECT panel, the potentiometer is marked —TG and is used to adjust the output for —130 volts dc.

(2) *Cover switch.* A cover switch is located on the bottom of each REG TUBE RECT panel (under the front cover). The switch contacts open when the cover of the REG TUBE RECT is removed and the 115-volt ac input power source is disconnected. The switch contacts close when the cover is replaced and the 115-volt ac input power source is connected to the REG TUBE RECT circuits. The cover switch provides protection for maintenance.

g. Rear Door. A microswitch is located inside the rear door of the teletypewriter test set (lower right-hand corner fig. 2). When the door is opened, the 115-volt ac power source is disconnected from all outlets at the rear of the teletypewriter test set except the convenience outlet for the extension light and/or soldering iron. When the door is closed, the ac power source is connected to all the outlets.

28. Extension Unit
(fig. 16)

The function of each control on the extension unit is described in *a* through *f* below.

a. BIAS and TOT DIST Meters. The BIAS and TOT DIST meters on the extension unit perform the same functions as the BIAS and TOTAL DIST meters on the teletypewriter test set (par. 27*a*).

b. SPD Switch. The SPD switch on the extension unit performs the same function as the CHG SPD switch on the teletypewriter test set (par. 27*d*).

c. POL–.060A–.020A Switch. The POL–.060A–.020A switch on the extension unit performs the same function as *both* the .020A switch and the POL switch on the teletypewriter test set (par. 27*d*).

(1) *Arrow pointing to .020A.* Arranges the teletypewriter test set for operation with 20-ma neutral circuits.

(2) *Arrow pointing to .060A.* Arranges the teletypewriter test set for operation with 60-ma neutral circuits.

(3) *Arrow pointing POL.* Arranges the teletypewriter test set for operation with polar circuits.

d. SIGS Lamp. The SIGS lamp functions as an indicator to inform the operator at an extension unit of the presence of teletypewriter signals on any circuit that is under test. It flashes irregularly when teletypewriter signals are present.

e. READ Switch. The READ switch, when operated, enables the operator to obtain distortion measurements for teletypewriter circuits which are connected to the extension unit.

f. TMS IN Jack, BSY Lamp, and RESET Switch. The TMS IN jack, BSY lamp, and RESET switch perform the same function as the identical controls on the teletypewriter test set (par. 27*d*).

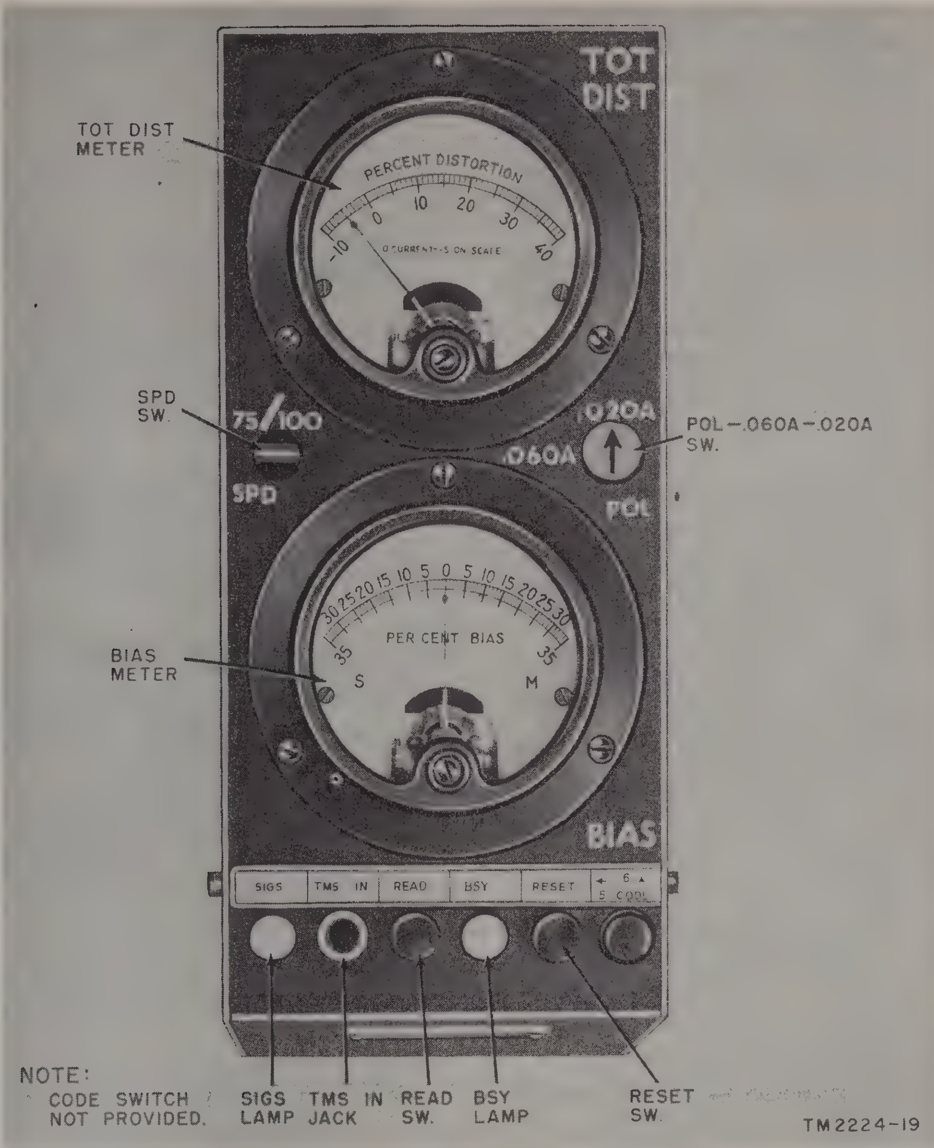

Figure 16. Extension unit, front view.

Section II. PRELIMINARY OPERATING ADJUSTMENTS

29. Meter and Power Supply Adjustments

After Teletypewriter Test Set TS–611A/FG has been installed and connected (pars. 12–25), make the meter adjustments (*a* below) with the power switch (POWER SWITCH PANEL, fig. 1) in the OFF position, and make the power supply adjustments (*b–d* below) with the power switch in the ON position. Allow the teletypewriter test set to warm up for a few minutes before making the power supply adjustments.

Caution: Dangerous voltages are present in the power supplies. When making voltage measurements, do not touch terminals or bare wires with the hands.

a. Meters (fig. 12). Zero-adjustment screws for meter needles are located on the faces of the meters.

(1) Adjust the screws for the meter needles on the BIAS, CONST CUR, and SC–REF VOLT meters until the meter needles rest at 0.

(2) Adjust the screw for the meter needle on the TOTAL DIST meter until the meter needle rests at —5.

b. Positive 130-volt Dc Supply.

(1) Arrange Multimeter TS–297/U for use with the 0- to 40-volt scale.

(2) Remove the cover of the REG TUBE RECT +TG panel (fig. 1).

(3) Connect the positive lead of the multimeter to terminal 7 of terminal board B.

(4) Connect the negative lead of the multimeter to terminal 8 of terminal board B.

(5) Operate the cover switch that is located below terminal board AC.

(6) Read the voltage indication on the multimeter.

(7) Adjust potentiometer R until the voltage indication on the multimeter is 130.

(8) Disconnect the test leads and replace the cover on the panel.

c. Negative 130-volt Dc Supply.

(1) Arrange Multimeter TS–297/U for use with the 0- to 40-volt scale.

(2) Remove the cover of the REG TUBE RECT —TG panel (fig. 1).

(3) Connect the positive lead of the multimeter to terminal 8 of terminal board B.

(4) Connect the negative lead of the multimeter to terminal 7 of terminal board B.

(5) Operate the cover switch that is located below terminal board AC.

(6) Read the voltage indication on the multimeter.

(7) Adjust potentiometer R until the voltage indication on the multimeter is 130.

(8) Disconnect the test leads and replace the cover on the panel.

d. 24-volt Dc Supply.

(1) Insert one end of a patch cord into the TMS IN jack (fig. 15).

(2) Operate the CHG SPD switch to its vertical position.

(3) Arrange Multimeter TS–297/U for use with the 0- to 40-volt dc scale.

(4) Connect the positive lead of the multimeter to terminal 8 of terminal board TB601, on the rear of the 24 VOLT SUP panel (fig. 2).

(5) Connect the negative lead of the multimeter to terminal 5 of terminal board TB601.

(6) Manually operate the microswitch (fig. 2) that is located at the bottom, rear side, of the teletypewriter test set. Tape the switch in the operated position.

(7) Read the voltage indication on the multimeter.

(8) Adjust resistor R601, on the rear of the 24 VOLT SUP panel, until the dc voltage indication on the multimeter is 24. Remove the tape from the microswitch.

(9) Disconnect the multimeter leads, remove the plug from the TMS IN jack, and turn the CHG SPD switch to its horizontal position.

30. Preliminary Adjustments and Checks for Testing 60-wpm, 60-ma, 5-unit Code, Neutral Transmission

(fig. 12 through 15)

a. Switch Adjustments.

(1) Set the CHG SPD, POL, and .020A switches so that the white line on each switch control is in a horizontal position.

(2) Set the CODE switch so that the arrow on the switch control points to 5.

b. Voltage and Current Adjustments.

(1) Set the SIGS switch so that the arrow on the switch control points to the left and insert a patch cord plug into the TMS IN jack.

(2) Adjust the CONST CUR potentiometer until the meter needle of the CONST CUR meter points to 30.

(3) Adjust the SC VOLT potentiometer until the meter needle of the SC–REF VOLT meter points to 55.

(4) Depress the REF VOLT switch and adjust the REF VOLT potentiometer until the meter needle of the SC–REF VOLT meter points to 55.

(5) Release the REF VOLT switch.

(6) Repeat the procedures outlined in (2) through (5) above and readjust if necessary.

c. Meter Distortion Adjustments.

(1) Turn the AMP ADJ potentiometer to its extreme clockwise position.

(2) Set the CHAR potentiometer at the middle of its limit of adjustment.

(3) Momentarily depress the RESET switch.

(4) Adjust the ZERO ADJ potentiometer until the meter needle of the TOTAL DIST meter points to —5.

(5) Set the SIGS switch so that the arrow on the switch control points upward.

(6) Patch 60-wpm, 60-ma, 5-unit code, neutral-type, distortion-free, miscellaneous test signals to the TMS IN jack. Use Distortion Test Set TS-383B/GG.

(7) Depress the CAL switch and keep it depressed.

(8) Adjust the BIAS potentiometer until the BIAS meter reading averages S15.

(9) Adjust the AMP ADJ potentiometer. Depress the RESET switch and observe the reading on the TOTAL DIST meter. Repeat the procedure until the reading on the TOTAL DIST meter rises to 10.

(10) Depress the REV CAL switch and keep it depressed. The BIAS meter reading should average S15.

(11) Depress the RESET switch momentarily. The TOTAL DIST meter reading should rise to 10. If the reading is less than 9 or more than 10, check rectifier tubes V301 and V302.

(12) Release the CAL and REV CAL switches.

Note. The COARSE and FINE switches and the DECR and ORIENT potentiometers, referred to in *d* through *f* below, are located on the right half of the DISTRIBUTOR panel.

d. Speed Adjustments.

(1) Set the ADJ SPD switch so that the white line on the switch control is in a vertical position.

(2) Adjust the COARSE and FINE switches to obtain a reading that is closest to the 0 on the BIAS meter.

(3) Set the ADJ SPD switch so that the white line on the switch control is in a horizontal position.

e. Decrement Adjustment.

(1) Turn the DECR potentiometer counterclockwise to its lowest setting.

(2) Depress the ADJ DECR switch and keep it depressed.

(3) Depress the RESET switch momentarily.

(4) Make a note of the reading on the TOTAL DIST meter.

(5) Set the SIGS switch so that the arrow on the switch control is pointing to the right and repeat the procedure given in (3) above.

(6) Adjust the DECR potentiometer until the meter reading obtained in (5) above is the same as the meter reading obtained in (3) above.

(7) Release the ADJ DECR switch and set the SIGS switch so that the arrow on the switch control points upward.

f. Orientation Adjustment.

(1) Depress the M–S ONLY switch and adjust the ORIENT potentiometer until the reading on the BIAS meter is 0.

(2) Release the M–S ONLY switch. The BIAS meter reading should be 0 ±1 percent.

(3) Depress the RESET switch momentarily. The reading on the TOTAL DIST meter should be between —5 percent and —2 percent. A meter reading above —2 percent indicates excessive internal distortion and this should be removed by checking the polar relays of the teletypewriter test set before proceeding further.

(4) Depress the M–S ONLY switch and adjust the ZERO ADJ potentiometer until the reading on the TOTAL DIST meter is 0.

(5) Release the M–S ONLY switch.

g. Operational Check.

(1) Transmit 60-wpm, 60-ma, 5-unit code, neutral-type test signals with known marking bias distortion.

(2) Make a note of the BIAS and TOTAL DIST meter readings.

(*a*) The amount of marking bias indicated on the BIAS meter should be equal to the known marking bias of the test signals.

(*b*) The indication on the TOTAL DIST meter should be the same in numerical value as that indicated on the BIAS meter.

(3) Transmit test signals with spacing bias distortion equal in magnitude to the test signals used in (1) above.

(*a*) The amount of bias indicated on the BIAS meter should be numerically equal to the bias indication obtained in (2) above; however, the BIAS meter will indicate spacing bias.

(*b*) The indication on the TOTAL DIST meter should be the same in numerical value as that indicated on the BIAS meter.

(4) Space bias indications must be within ±2 percent of mark bias indications.

(5) Remove the patch cord plug from the TMS IN jack.

31. Preliminary Adjustments and Checks for Testing 66-wpm, 60-ma, 5-unit Code, Neutral Transmission

(figs. 12–15)

a. Switch Adjustments.

(1) Set the CHG SPD, POL, and .020A switches so that the white line on each switch control is in a horizontal position.

(2) Set the CODE switch so that the arrow on the switch control points to 5.

b. Voltage and Current Adjustments.

(1) Set the SIGS switch so that the arrow on the switch control points to the left and insert a patch cord plug into the TMS IN jack.

(2) Adjust the CONST CUR potentiometer until the meter needle of the CONST CUR meter points to 30.

(3) Adjust the SC VOLT potentiometer until the meter needle of the SC–REF VOLT meter points to 55.

(4) Depress the REF VOLT switch and adjust the REF VOLT potentiometer until the meter needle of the SC–REF VOLT meter points to 55.

(5) Release the REF VOLT switch.

(6) Repeat the procedures outlined in (2) through (5) above and readjust if necessary.

c. Meter Distortion Adjustments.

(1) Turn the AMP ADJ potentiometer to its extreme clockwise position.

(2) Set the CHAR potentiometer at the middle of its limit of adjustment.

(3) Momentarily depress the RESET switch.

(4) Adjust the ZERO ADJ potentiometer until the meter needle of the TOTAL DIST meter points to —5.

(5) Set the SIGS switch so that the arrow on the switch control points upward.

(6) Patch 66-wpm, 60-ma, 5-unit code, neutral-type, distortion-free, miscellaneous test signals to the TMS IN jack. Use Distortion Test Set TS–383B/GG.

(7) Depress the CAL switch and keep it depressed until the adjustments in (8) through (10) below have been completed.

(8) Adjust the BIAS potentiometer until the BIAS meter reading averages S15.

(9) Adjust the AMP ADJ potentiometer while repeatedly operating the RESET switch until the reading on the TOTAL DIST meter rises to 10 between operations of the RESET switch.

(10) Depress the REV CAL switch and keep it depressed. The BIAS meter reading should average S15.

(11) Depress the RESET switch momentarily. The TOTAL DIST meter reading should rise to 10. If the reading is less than 9 or more than 10, check rectifier tubes V301 and V302.

(12) Release the CAL and REV CAL switches.

Note. The COARSE and FINE switches and the DECR and ORIENT potentiometers, referred to in *d* through *f* below, are located on the left half of the DISTRIBUTOR panel.

d. Speed Adjustments.

(1) Set the ADJ SPD switch so that the white line on the switch control is in a vertical position.

(2) Adjust the COARSE and FINE switches to obtain a reading that is closest to 0 on the BIAS meter.

(3) Set the ADJ SPD switch so that the white line on the switch control is in a horizontal position.

e. Decrement Adjustment.

(1) Turn the DECR potentiometer counterclockwise to its lowest setting.

(2) Depress the ADJ DECR switch and keep it depressed.

(3) Depress the RESET switch momentarily.

(4) Make a note of the reading on the TOTAL DIST meter.

(5) Set the SIGS switch so that the arrow on the switch control is pointing to the right and repeat the procedure given in (3) above.

(6) Adjust the DECR potentiometer until the meter reading obtained in (5) above is the same as the meter reading obtained in (3) above.

(7) Release the ADJ DECR switch and set the SIGS switch so that the arrow on the switch control points upward.

f. Orientation Adjustment.

(1) Depress the M–S ONLY switch and adjust the ORIENT potentiometer until the reading on the BIAS meter is 0.

(2) Release the M–S ONLY switch. The BIAS meter reading should be 0 ±1 percent.

(3) Depress the RESET switch momentarily. The reading on the TOTAL DIST meter should be between −5 percent and −2 percent. A meter reading above −2 percent indicates excessive internal distortion and this should be removed by checking the polar relays of the teletypewriter test set before proceeding further.

(4) Depress the M–S ONLY switch and adjust the ZERO ADJ potentiometer until the reading on the TOTAL DIST meter is 0.

(5) Release the M–S ONLY switch.

g. Operational Check.

(1) Transmit 66-wpm, 60-ma, 5-unit code, neutral-type test signals with known marking bias distortion.

(2) Make a note of the BIAS and TOTAL DIST meter readings.

(*a*) The amount of marking bias indicated on the BIAS meter should be equal to the known marking bias of the test signals.

(*b*) The indication on the TOTAL DIST meter should be the same in numerical value as that indicated on the BIAS meter.

(3) Transmit test signals with spacing bias distortion equal in magnitude to the test signals used in (1) above.

(*a*) The amount of bias indicated on the BIAS meter should be numerically equal to the bias indication obtained in (2) above; however, the BIAS meter will indicate spacing bias.

(*b*) The indication on the TOTAL DIST meter should be the same in numerical value as that indicated on the BIAS meter.

(4) Space bias indications must be within ±2 percent of mark bias indications.

(5) Remove the patch cord plug from the TMS IN jack.

32. Preliminary Adjustments and Checks for Testing 75-wpm, 60-ma, 5-unit Code, Neutral Transmission

(figs. 12–15)

a. Switch Adjustments.

(1) Set the POL and .020A switches so that the white line on each switch control is in a horizontal position.

(2) Set the CHG SPD switch so that the white line on the switch control is in a vertical position.

(3) Set the CODE switch so that the arrow on the switch control points to 5.

(4) Operate the SPEED switch to position 75.

b. Voltage and Current Adjustments.

(1) Set the SIGS switch so that the arrow on the switch control points to the left and insert a patch cord plug into the TMS IN jack.

(2) Adjust the CONST CUR potentiometer until the meter needle of the CONST CUR meter points to 30.

(3) Adjust the SC VOLT potentiometer until the meter needle of the SC–REF VOLT meter points to 55.

(4) Depress the REF VOLT switch and adjust the REF VOLT potentiometer until the meter needle of the SC–REF VOLT meter points to 55.

(5) Release the REF VOLT switch.

(6) Repeat the procedures outlined in (2) through (5) above and readjust if necessary.

c. Meter Distortion Adjustments.

(1) Turn the AMP ADJ potentiometer to its extreme clockwise position.

(2) Set the CHAR potentiometer at the middle of its limit of adjustment.

(3) Momentarily depress the RESET switch.

(4) Adjust the ZERO ADJ potentiometer until the meter needle of the TOTAL DIST meter points to —5.

(5) Set the SIGS switch so that the arrow on the switch control points upward.

(6) Patch 75-wpm, 60-ma, 5-unit code, neutral-type, distortion-free, miscellaneous test signals to the TMS IN jack. Use Distortion Test Set TS–383B/GG.

(7) Depress the CAL switch and keep it depressed until the adjustments in (8) through (10) below have been completed.

(8) Adjust the BIAS potentiometer until the BIAS meter reading averages S15.

(9) Adjust the AMP ADJ potentiometer while repeatedly operating the RESET switch until the reading on the TOTAL DIST meter rises to 10 between operations of the RESET switch.

(10) Depress the REV CAL switch and keep it depressed. The BIAS meter reading should average S15.

(11) Depress the RESET switch momentarily. The TOTAL DIST meter reading should rise to 10. If the reading is less than 9 or more than 10, check rectifier tubes V301 and V302.

(12) Release the CAL and REV CAL switches.

Note. The COARSE and FINE switches and the DECR and ORIENT potentiometers, referred to in *d* through *f* below, are located on the left half of the DISTRIBUTOR panel.

d. Speed Adjustments.

(1) Set the ADJ SPD switch so that the white line on the switch control is in a vertical position.

(2) Adjust the COARSE and FINE switches to obtain a reading that is closest to the 0 on the BIAS meter.

(3) Set the ADJ SPD switch so that the white line on the switch control is in a horizontal position.

e. Decrement Adjustment.

(1) Turn the DECR potentiometer counterclockwise to its lowest setting.

(2) Depress the ADJ DECR switch and keep it depressed.

(3) Depress the RESET switch momentarily.

(4) Make a note of the reading on the TOTAL DIST meter.

(5) Set the SIGS switch so that the arrow on the switch control is pointing to the right and repeat the procedure given in (3) above.

(6) Adjust the DECR potentiometer until the meter reading obtained in (5) above is the same as the meter reading obtained in (3) above.

(7) Release the ADJ DECR switch and set the SIGS switch so that the arrow on the switch control points upward.

f. Orientation Adjustment.

(1) Depress the M–S ONLY switch and adjust the ORIENT potentiometer until the reading on the BIAS meter is 0.

(2) Release the M–S ONLY switch. The BIAS meter reading should be 0 ±1 percent.

(3) Depress the RESET switch momentarily. The reading on the TOTAL DIST meter should be between —5 percent and —2 percent. A meter reading above —2 percent indicates excessive internal distortion and this should be removed by checking the polar relays of the teletypewriter test set before proceeding further.

(4) Depress the M–S ONLY switch and adjust the ZERO ADJ potentiometer until the reading on the TOTAL DIST meter is 0.

(5) Release the M–S ONLY switch.

g. Operational Check.

(1) Transmit 75-wpm, 60-ma, 5-unit code, neutral-type test signals with known marking bias distortion.

(2) Make a note of the BIAS and TOTAL DIST meter readings.

(*a*) The amount of marking bias indicated on the BIAS meter should be

equal to the known marking bias of the test signals.

(b) The indication on the TOTAL DIST meter should be the same in numerical value as that indicated on the BIAS meter.

(3) Transmit test signals with spacing bias distortion equal in magnitude to the test signals used in (1) above.

(a) The amount of bias indicated on the BIAS meter should be numerically equal to the bias indication obtained in (2) above; however, the BIAS meter will indicate spacing bias.

(b) The indication on the TOTAL DIST meter should be the same numerical value as that indicated on the BIAS meter.

(4) Space bias indications must be within ±2 percent of mark bias indications.

(5) Remove the patch cord plug from the TMS IN jack.

33. Preliminary Adjustments and Checks for Testing 100 wpm, 60-ma, 5-unit Code, Neutral Transmission

(figs. 12–15)

a. *Switch Adjustments.*

(1) Set the POL and .020A switches so that the white line on each switch control is in a horizontal position.

(2) Set the CHG SPD switch so that the white line on the switch control is in a vertical position.

(3) Set the CODE switch so that the arrow on the switch control points to 5.

(4) Operate the SPEED switch to position 100.

b. *Voltage and Current Adjustments.*

(1) Set the SIGS switch so that the arrow on the switch control points to the left and insert a patch cord plug into the TMS IN jack.

(2) Adjust the CONST CUR potentiometer until the meter needle of the CONST CUR meter points to 30.

(3) Adjust the SC VOLT potentiometer until the meter needle of the SC–REF VOLT meter points to 55.

(4) Depress the REF VOLT switch and adjust the REF VOLT potentiometer until the meter needle of the SC–REF VOLT meter points to 55.

(5) Release the REF VOLT switch.

(6) Repeat the procedures outlined in (2) through (5) above and readjust if necessary.

c. *Meter Distortion Adjustments.*

(1) Turn the AMP ADJ potentiometer to its extreme clockwise position.

(2) Set the CHAR potentiometer at the middle of its limit of adjustment.

(3) Momentarily depress the RESET switch.

(4) Adjust the ZERO ADJ potentiometer until the meter needle of the TOTAL DIST meter points to —5.

(5) Set the SIGS switch so that the arrow on the switch control points upward.

(6) Patch 100-wpm, 60-ma, 5-unit code, neutral-type, distortion-free, miscellaneous test signals to the TMS IN jack. Use Distortion Test Set TS–383B/GG.

(7) Depress the CAL switch and keep it depressed until the adjustments in (8) through (10) below have been completed.

(8) Adjust the BIAS potentiometer until the BIAS meter reading averages S15.

(9) Adjust the AMP ADJ potentiometer while repeatedly operating the RESET switch until the reading on the TOTAL DIST meter rises to 10 between operations of the RESET switch.

(10) Depress the REV CAL switch and keep it depressed. The BIAS meter reading should average S15.

(11) Depress the RESET switch momentarily. The TOTAL DIST meter reading should rise to 10. If the reading is less than 9 or more than 10, check rectifier tubes V301 and V302.

(12) Release the CAL and REV CAL switches.

Note. The COARSE and FINE switches and the DECR and ORIENT potentiometers, referred to in d through f below, are located on the left half of the DISTRIBUTOR panel.

d. *Speed Adjustments.*

(1) Set the ADJ SPD switch so that the white line on the switch control is in vertical position.

(2) Adjust the COARSE and FINE switches to obtain a reading that is closest to the 0 on the BIAS meter.

(3) Set the ADJ SPD switch so that the white line on the switch control is in a horizontal position.

e. Decrement Adjustment.

(1) Turn the DECR potentiometer counterclockwise to its lowest setting.

(2) Depress the ADJ DECR switch and keep it depressed.

(3) Depress the RESET switch momentarily.

(4) Make a note of the reading on the TOTAL DIST meter.

(5) Set the SIGS switch so that the arrow on the switch control is pointing to the right and repeat the procedure given in (3) above.

(6) Adjust the DECR potentiometer until the meter reading obtained in (5) above is the same as the meter reading obtained in (3) above.

(7) Release the ADJ DECR switch and set the SIGS switch so that the arrow on the switch control points upward.

f. Orientation Adjustment.

(1) Depress the M–S ONLY switch and adjust the ORIENT potentiometer until the reading on the BIAS meter is 0.

(2) Release the M–S ONLY switch. The BIAS meter reading should be 0 ±1 percent.

(3) Depress the RESET switch momentarily. The reading on the TOTAL DIST meter should be between —5 percent and —2 percent. A meter reading above —2 percent indicates excessive internal distortion and this should be removed by checking the polar relays of the teletypewriter test set before proceeding further.

(4) Depress the M–S ONLY switch and adjust the ZERO ADJ potentiometer until the reading on the TOTAL DIST meter is 0.

(5) Release the M–S ONLY switch.

g. Operational Check.

(1) Transmit 100-wpm, 60-ma, 5-unit code, neutral-type test signals with known marking bias distortion.

(2) Make a note of the BIAS and TOTAL DIST meter readings.

(*a*) The amount of marking bias indicated on the BIAS meter should be equal to the known marking bias of the test signals.

(*b*) The indication on the TOTAL DIST meter should be the same in numerical value as that indicated on the BIAS meter.

(3) Transmit test signals with spacing bias distortion equal in magnitude to the test signals used in (1) above.

(*a*) The amount of bias indicated on the BIAS meter should be numerically equal to the bias indication obtained in (2) above; however, the BIAS meter will indicate spacing bias.

(*b*) The indication on the TOTAL DIST meter should be the same numerical value as that indicated on the BIAS meter.

(4) Space bias indications must be within ±2 percent of mark bias indications.

(5) Remove the patch cord plug from the TMS IN jack.

34. Preliminary Adjustments and Checks for Testing Other Type of Transmission (fig. 17)

The preliminary adjustments and checks described in paragraphs 30 through 33 are essentially the same for all types of transmission. To make the preliminary adjustments and checks at the teletypewriter test set for any type of circuit operation listed in chart 1 (fig. 17), proceed as follows:

a. Read down the *type of circuit operation* column and select the particular type of circuit operation that is to be tested with the teletypewriter test set.

b. Read across the chart to obtain information concerning the *required switch settings at the teletypewriter test set* for the particular type of circuit operation selected.

c. Make the preliminary adjustments and checks, changing *only* those switch settings specified in chart 1.

(1) For circuits operating at speeds of 60 wpm, use the procedures in paragraph 30.

(2) For circuits operating at speeds of 66 wpm, use the procedures in paragraph 31.

(3) For circuits operating at speeds of 75 wpm, use the procedures in paragraph 32.

(4) For circuit operating at speeds of 100 wpm, use the procedures in paragraph 33.

CHART I

TYPE OF CIRCUIT OPERATION				REQUIRED SWITCH SETTINGS AT THE TELETYPEWRITER TEST SET		
SPEED (WPM)	CURRENT (MA)	CODE UNITS	TYPE OF SIGNAL	.020A SWITCH	CODE 5-6 SWITCH	POL SWITCH
60	20	5	NEUTRAL	⦶		
66	20	5	NEUTRAL	⦶		
75	20	5	NEUTRAL	⦶		
100	20	5	NEUTRAL	⦶		
60	60	6	NEUTRAL		6	
66	60	6	NEUTRAL		6	
75	60	6	NEUTRAL		6	
100	60	6	NEUTRAL		6	
60	20	6	NEUTRAL	⦶	6	
66	20	6	NEUTRAL	⦶	6	
75	20	6	NEUTRAL	⦶	6	
100	20	6	NEUTRAL	⦶	6	
60	30	5	POLAR			⦶
66	30	5	POLAR			⦶
75	30	5	POLAR			⦶
100	30	5	POLAR			⦶
60	30	6	POLAR		6	⦶
66	30	6	POLAR		6	⦶
75	30	6	POLAR		6	⦶
100	30	6	POLAR		6	⦶

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Figure 17. Switch setting chart for the teletypewriter test set.

35. Starting Procedures

Make the meter and power supply adjustments (par. 29) if the teletypewriter test set is being used for the first time after its installation or if it has been inoperative for a long period of time. If the meter and power supply adjustments have been made previously and if the teletypewriter test set has been in continuous use, it is unnecessary to repeat these adjustments. In this case, start with the operating procedures (par. 36).

36. Operating Procedures

a. Observe the BSY lamp at the teletypewriter test set.

(1) If the BSY lamp is not lighted, insert one end of a patch cord into the TMS IN jack.

(2) If the BSY lamp is lighted, the teletypewriter test set is being used from one of the extension units. Wait until the BSY lamp is extinguished and then insert one end of a patch cord into the TMS IN jack.

b. At the teletypewriter test set, make the preliminary adjustments and checks necessary for the type of circuit operation that is to be tested (pars. 30–34).

(1) If the circuit to be tested is to be patched to the teletypewriter test set, no further adjustments are necessary.

(2) If the circuit to be tested is to be patched to an extension unit, set the switches on the extension unit by using the information contained in chart 2 (fig. 18).

c. Patch the circuit to be tested to the TMS IN jack.

Note. To prevent interference on a working circuit when it is being patched to the teletypewriter test set or to an extension unit, always insert the plug on one end of the patch cord into the TMS IN jack before inserting the plug on the other end into the jack appearance for the working circuit. When removing the patch cord, pull the plug out of the TMS IN jack, last.

d. Send the *fox* test sentence over the circuit that is to be tested, for a period of 4 minutes. Send the test sentence for more than 4 minutes if greater accuracy is desired.

e. Record the average indications of the BIAS and TOTAL DIST meters.

(1) Obtain meter indications at the teletypewriter test set by depressing the RESET switch at 30-second intervals.

(2) Obtain meter indications at an extension unit by keeping the READ switch depressed while depressing the RESET switch at 30-second intervals.

(3) Obtain more accurate indications on the BIAS meter when 6-unit code is used by multiplying the meter indication by .9.

f. Compare the BIAS and TOTAL DIST meter indications obtained in *e* above with those listed on the circuit record card.

(1) If the meter readings obtained agree with those on the circuit record card, the circuit is operating properly and no further action is required.

(2) If the meter readings obtained do not agree with those on the circuit record card, corrective action should be recommended to the wire chief and/or the communications officer.

g. Remove the patch cord plug from the TMS IN jack as soon as the tests have been completed.

37. Stopping Procedures

If operation of the teletypewriter test set is to be stopped for a long period of time, operate the power switch on the POWER SWITCH panel (fig. 1) to the OFF position. If the teletypewriter test set is to be used frequently, but not necessarily on a full time basis, it is unwise to remove power from the teletypewriter test set during the intervals that it is idle, because preliminary operating checks (par. 29) are required each time power is applied to the teletypewriter test set.

CHART 2

TYPE OF CIRCUIT OPERATION				REQUIRED SWITCH SETTINGS AT EXTENSION UNITS	
SPEED (WPM)	CURRENT (MA)	CODE UNITS	TYPE OF SIGNAL	.020A-.060A-POL SWITCH	SPD 75/100 SWITCH
60	60	5	NEUTRAL	←	⊖
66	60	5	NEUTRAL	←	⊖
75	60	5	NEUTRAL	←	⦶
100	60	5	NEUTRAL	←	⦶
60	20	5	NEUTRAL	↑	⊖
66	20	5	NEUTRAL	↑	⊖
75	20	5	NEUTRAL	↑	⦶
100	20	5	NEUTRAL	↑	⦶
60	60	6	NEUTRAL	←	⊖
66	60	6	NEUTRAL	←	⊖
75	60	6	NEUTRAL	←	⦶
100	60	6	NEUTRAL	←	⦶
60	20	6	NEUTRAL	↑	⊖
66	20	6	NEUTRAL	↑	⊖
75	20	6	NEUTRAL	↑	⦶
100	20	6	NEUTRAL	↑	⦶
60	30	5	POLAR	↓	⊖
66	30	5	POLAR	↓	⊖
75	30	5	POLAR	↓	⦶
100	30	5	POLAR	↓	⦶
60	30	6	POLAR	↓	⊖
66	30	6	POLAR	↓	⊖
75	30	6	POLAR	↓	⦶
100	30	6	POLAR	↓	⦶

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Figure 18. Switch settings for an extension unit.

38. General

Teletypewriter Test Set TS–611A/FG is fixed-plant equipment and is usually installed in a permanent-type building that has a controlled temperature. Such a shelter is not always available in regions where extreme cold, heat, humidity, and moisture, or sand conditions prevail. Paragraphs 39 through 41 contain instructions for minimizing the effect of these unusual operating conditions.

39. Operation in Arctic Climates

Subzero temperatures and climatic conditions associated with cold weather affect efficient operation of the equipment. Instructions and precautions for operation under such adverse conditions follow:

a. Handle the equipment carefully. Extreme cold makes parts brittle and increases the possibility of breakage.

b. Keep the equipment warm and dry. Keep the power on and the tube heaters lighted unless this procedure causes an excessive drain on the power supply.

c. Do not allow cold drafts to come in contact with the glass envelopes of heated tubes. A cold draft may shatter the envelopes.

d. When equipment that has been exposed to the cold is brought into a warm room, it will sweat until it reaches room temperature. When it reaches room temperature, dry it thoroughly. This condition also arises when equipment warms up during the day after being shut off at night in an unheated inclosure. Maintain the equipment in operation at night if the power supply permits.

40. Operation in Tropical Climates

When the equipment is installed in an improvised shelter in swampy areas, it is subject to moisture conditions that are more acute than normal in the tropics. Ventilation is usually very poor and the high relative humidity causes condensation of moisture on the equipment whenever the temperature of the equipment becomes lower than the temperature of the surrounding air. To minimize this condition, provide forced air ventilation with an air filter. Operate the equipment with its rear door closed. Keep the power on and the tubes lighted unless this causes an excessive drain on the power supply.

41. Operation in Desert Climates

a. Conditions similar to those encountered in tropical climates (par. 40) often prevail in desert areas. Use the same measures to insure proper operation of the equipment.

b. The main problem that arises with the equipment operation in desert areas is the large amount of dust and sand that enters the equipment. The equipment should be inclosed in a dustproof shelter. Hang wet sacking over the windows and doors.

c. Make frequent preventive maintenance checks. Under desert conditions, the equipment should be kept free of oil and grease, which may combine with dust, sand, or dirt to form grit, which will damage the equipment.

CHAPTER 4
ORGANIZATIONAL MAINTENANCE

Section I. TOOLS AND TEST EQUIPMENT

42. General

a. The type of organizational maintenance that can be performed is limited to a large extent by existing military regulations (Standard Operating Procedures) and by the tools, materials, replaceable parts, and test equipments that are available in the organization.

b. No tools, materials, or test equipments are supplied with Teletypewriter Test Set TS–611A/FG.

c. Tools, materials, and test equipments (par. 43) that are authorized for the performance of organizational maintenance on Teletypewriter Test Set TS–611A/FG can be obtained through the organization supply officer.

43. Tools, Materials, and Test Equipments

Tools, materials, and test equipments required, but not supplied, for organizational maintenance of Teletypewriter Test Set TS–611A/FG are listed below:

a. Tools.
- (1) Tool Equipment TE–41.
- (2) Tube pin straightener.

b. Materials.
- (1) Crocus cloth.
- (2) Orange sticks.
- (3) Cheesecloth, bleached, lint-free.
- (4) Cleaning Compound (Federal stock No. 7930–395–9542).
- (5) Toothpicks.

c. Test Equipments.
- (1) Multimeter TS–297/U.
- (2) Distortion Test Set TS–383B/GG.
- (3) Electron Tube Test Set TV–7/U.

Section II. PREVENTIVE MAINTENANCE SERVICES

44. Definition of Preventive Maintenance

Preventive maintenance is work performed on equipment (usually when the equipment is not in use) to keep it in good working order. Preventive maintenance, properly performed, will keep breakdowns and needless interruptions in service to a minimum. Preventive maintenance differs from troubleshooting and repair since its object is to *prevent the occurrence of troubles* rather than to repair the troubles. Refer to AR 750–5, Maintenance Responsibilities and Shop Operation.

45. General Preventive Maintenance Techniques

a. Use crocus cloth to remove corrosion.

b. Use cheesecloth to clean all parts of the equipment (including electrical contacts). If necessary, moisten the cloth with Cleaning Compound; then wipe the parts dry with a clean cloth.

Warning: Prolonged breathing of Cleaning Compound fumes is dangerous. Make sure adequate ventilation is provided. Cleaning compound is flammable; do not use near a flame.

c. If available, dry compressed air may be used at a line pressure not exceeding 60 pounds per square inch to remove dust from inaccessible places. *Be careful* or mechanical damage from the air blast may result.

d. For further information on preventive maintenance techniques, refer to TB SIG 123, Preventive Maintenance Practices for Ground Signal Equipment.

OPERATOR FIRST ECHELON MAINTENANCE CHECK LIST FOR SIGNAL CORPS EQUIPMENT
RADIO COMMUNICATION, DIRECTION FINDING, CARRIER, RADAR

INSTRUCTIONS: See other side

EQUIPMENT NOMENCLATURE	EQUIPMENT SERIAL NO.

LEGEND FOR MARKING CONDITIONS: ✓ Satisfactory; X Adjustment, repair or replacement required; (X) Defect corrected.
NOTE: Strike out items not applicable.

DAILY

NO.	ITEM	CONDITION S	M	T	W	T	F	S
1	COMPLETENESS AND GENERAL CONDITION OF EQUIPMENT ~~(receivers, transmitters, carrying cases~~, (wire and cable, ~~microphones~~, tubes, spare parts, technical manuals and accessories). PAR. 7, 10 AND 16							
2	LOCATION AND INSTALLATION SUITABLE FOR NORMAL OPERATION. PAR. 12							
3	CLEAN DIRT AND MOISTURE FROM ~~ANTENNA, MICROPHONE, HEADSETS, CHESTSETS,~~ KEYS, JACKS, PLUGS, ~~TELEPHONES, CARRYING BAGS,~~ COMPONENT PANELS. PAR. 45							
4	INSPECT SEATING OF READILY ACCESSIBLE "PLUCK-OUT" ITEMS: TUBES, LAMPS, ~~CRYSTALS,~~ FUSES, ~~CONNECTORS,~~ RELAYS, ~~VIBRATORS, PLUG-IN COILS AND RESISTORS.~~ PAR 52							
5	INSPECT CONTROLS FOR BINDING, SCRAPING, EXCESSIVE LOOSENESS, ~~WORN OR CHIPPED GEARS,~~ MISALIGNMENT, POSITIVE ACTION. PAR. 27, 28							
6	CHECK FOR NORMAL OPERATION. PAR. 29-37, 55							

WEEKLY

NO.	ITEM	CONDITION	NO.	ITEM	CONDITION
7	CLEAN AND TIGHTEN EXTERIOR OF COMPONENTS AND CASES, RACK MOUNTS, ~~SHOCK MOUNTS, ANTENNA MOUNTS, COAXIAL TRANSMISSION LINES, WAVE GUIDES, AND CABLE CONNECTIONS.~~ PAR. 47		13	~~INSPECT STORAGE BATTERIES FOR DIRT, LOOSE TERMINALS, ELECTROLYTE LEVEL AND SPECIFIC GRAVITY, AND DAMAGED CASES.~~	
8	INSPECT CASES, MOUNTINGS, ~~ANTENNAS, TOWERS,~~ AND EXPOSED METAL SURFACES, FOR RUST, CORROSION, AND MOISTURE. PAR. 48, 49		14	CLEAN ~~AIR FILTERS, BRASS NAME PLATES,~~ DIAL AND METER WINDOWS, ~~JEWEL ASSEMBLIES.~~ PAR. 47	
9	INSPECT CORD, CABLE, WIRE, ~~AND SHOCK MOUNTS~~ FOR CUTS, BREAKS, FRAYING, DETERIORATION, KINKS, AND STRAIN. PAR. 47 b(5)		15	INSPECT METERS FOR DAMAGED GLASS AND CASES. PAR. 47	
10	~~INSPECT ANTENNA FOR ECCENTRICITIES, CORROSION, LOOSE FIT, DAMAGED INSULATORS AND REFLECTORS.~~		16	~~INSPECT SHELTERS AND COVERS FOR ADEQUACY OF WEATHERPROOFING.~~	
11	~~INSPECT CANVAS ITEMS, LEATHER, AND CABLING FOR MILDEW, TEARS, AND FRAYING.~~		17	~~CHECK ANTENNA GUY WIRES FOR LOOSENESS AND PROPER TENSION.~~	
12	INSPECT FOR LOOSENESS OF ACCESSIBLE ITEMS: SWITCHES, KNOBS, JACKS, CONNECTORS, ELECTRICAL TRANSFORMERS, ~~POWERSTATS,~~ RELAYS, ~~SELSYNS, MOTORS, BLOWERS,~~ CAPACITORS, ~~GENERATORS,~~ AND PILOT LIGHT ASSEMBLIES. PAR. 47		18	~~CHECK TERMINAL BOX COVERS FOR CRACKS, LEAKS, DAMAGED GASKETS, DIRT AND GREASE.~~	

19 IF DEFICIENCIES NOTED ARE NOT CORRECTED DURING INSPECTION, INDICATE ACTION TAKEN FOR CORRECTION. PAR. 46

DA FORM 1 MAY 51 11-238 REPLACES DA AGO FORM 419, 1 DEC 50, WHICH IS OBSOLETE.

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Figure 19. DA Form 11-238.

SECOND AND THIRD ECHELON MAINTENANCE CHECK LIST FOR SIGNAL CORPS EQUIPMENT

RADIO COMMUNICATION, DIRECTION FINDING, CARRIER, RADAR

INSTRUCTIONS: See other side

EQUIPMENT NOMENCLATURE	EQUIPMENT SERIAL NO.

LEGEND FOR MARKING CONDITIONS: ✓ Satisfactory; X Adjustment, repair or replacement required; (X) Defect corrected.
NOTE: Strike out items not applicable.

NO.	ITEM	CONDITION	NO.	ITEM	CONDITION
1	COMPLETENESS AND GENERAL CONDITION OF EQUIPMENT ~~(receiver, transmitter, carrying cases,~~ *(wire and cable,* ~~*microphone,*~~ *tubes, spare parts, technical manuals and accessories).* PAR. 7, 10 AND 16		19	ELECTRON TUBES - INSPECT FOR LOOSE ENVELOPES, CAP CONNECTORS, CRACKED SOCKETS: INSUFFICIENT SOCKET SPRING TENSION; CLEAN DUST AND DIRT CAREFULLY; CHECK EMISSION OF RECEIVER TYPE TUBES. PAR. 52, 53	
2	LOCATION AND INSTALLATION SUITABLE FOR NORMAL OPERATION. PAR. 12		20	~~INSPECT [illegible] CUT-OUTS FOR LOOSE PARTS, DIRT, MISALIGNMENT AND CORROSION.~~	
3	CLEAN DIRT AND MOISTURE FROM ~~ANTENNA, MICROPHONE, HEADSETS, CHESTSETS~~, KEYS, JACKS, PLUGS, ~~TELEPHONES, CARRYING BAGS,~~ COMPONENT PANELS. PAR. 45		21	INSPECT FIXED CAPACITORS FOR LEAKS, BULGES, AND DISCOLORATION. PAR. 121	
4	INSPECT SEATING OF READILY ACCESSIBLE "PLUCK-OUT" ITEMS: TUBES, LAMPS, ~~CRYSTALS~~, FUSES, ~~CONNECTORS, VIBRATORS~~ RELAYS. ~~PLUG-IN COILS AND RESISTORS~~. PAR. 52		22	INSPECT RELAY AND CIRCUIT BREAKER ASSEMBLIES FOR LOOSE MOUNTINGS; BURNED, PITTED, CORRODED CONTACTS; MISALIGNMENT OF CONTACTS AND SPRINGS; INSUFFICIENT SPRING TENSION; BINDING OF PLUNGERS AND HINGE PARTS. PAR. 122	
5	INSPECT CONTROLS FOR BINDING, SCRAPING, EXCESSIVE LOOSENESS, ~~WORN OR CHIPPED GEARS~~, MISALIGNMENT, POSITIVE ACTION. PAR. 27, 28		23	~~INSPECT VARIABLE CAPACITORS FOR DIRT, MOISTURE, MISALIGNMENT OF PLATES, AND LOOSE MOUNTINGS~~.	
6	CHECK FOR NORMAL OPERATION. PAR. 29-37, 55		24	INSPECT RESISTORS, BUSHINGS, AND INSULATORS, FOR CRACKS, CHIPPING, BLISTERING, DISCOLORATION AND MOISTURE. PAR. 121	
7	CLEAN AND TIGHTEN EXTERIOR OF COMPONENTS AND CASES, RACK MOUNTS, ~~SHOCK MOUNTS, ANTENNA MOUNTS, COAXIAL TRANSMISSION LINES, WAVE GUIDES, AND CABLE CONNECTIONS.~~ PAR. 47		25	~~INSPECT TERMINALS OF LARGE FIXED CAPACITORS AND RESISTORS FOR CORROSION, DIRT AND LOOSE CONTACTS.~~	
8	INSPECT CASES, MOUNTINGS, ~~ANTENNAS, TOWERS,~~ AND EXPOSED METAL SURFACES, FOR RUST, CORROSION, AND MOISTURE. PAR. 48, 49		26	CLEAN AND TIGHTEN SWITCHES, TERMINAL BLOCKS, ~~BLOWERS,~~ RELAY CASES, AND INTERIORS OF CHASSIS AND CABINETS NOT READILY ACCESSIBLE. PAR. 47	
9	INSPECT CORD, CABLE, WIRE, ~~AND SHOCK MOUNTS~~ FOR CUTS, BREAKS, FRAYING, DETERIORATION, KINKS, AND STRAIN. PAR. 47 b(5)		27	INSPECT TERMINAL BLOCKS FOR LOOSE CONNECTIONS, CRACKS AND BREAKS. PAR. 47	
10	~~INSPECT ANTENNA FOR ECCENTRICITIES, CORROSION, LOOSE FIT, DAMAGED INSULATORS AND REFLECTORS~~.		28	CHECK SETTINGS OF ADJUSTABLE RELAYS. PAR. 122	
11	~~INSPECT CANVAS ITEMS, LEATHER, AND CABLING FOR MILDEW, TEARS, AND FRAYING~~.		29	~~LUBRICATE EQUIPMENT IN ACCORDANCE WITH APPLICABLE DEPARTMENT OF THE ARMY LUBRICATION ORDER.~~	
12	INSPECT FOR LOOSENESS OF ACCESSIBLE ITEMS: SWITCHES, KNOBS, JACKS, CONNECTORS, ELECTRICAL TRANSFORMERS, ~~POWERSTATS,~~ RELAYS, ~~SELSYNS, MOTORS, BLOWERS~~, CAPACITORS, ~~GENERATORS,~~ AND PILOT LIGHT ASSEMBLIES. PAR. 47		30	~~INSPECT GENERATORS, AMPLIDYNES, DYNAMOTORS, FOR BRUSH WEAR, SPRING TENSION, ARCING, AND FITTING OF COMMUTATOR~~.	
13	~~INSPECT STORAGE BATTERIES FOR DIRT, LOOSE TERMINALS, ELECTROLYTE LEVEL AND SPECIFIC GRAVITY, AND DAMAGED CASES~~.		31	CLEAN AND TIGHTEN CONNECTIONS AND MOUNTINGS FOR TRANSFORMERS, CHOKES, POTENTIOMETERS, AND RHEOSTATS. PAR. 47	
14	CLEAN ~~AIR FILTERS, BRASS NAME PLATES~~, DIAL AND METER WINDOWS. ~~JEWEL ASSEMBLIES~~. PAR. 47		32	INSPECT TRANSFORMERS, CHOKES, POTENTIOMETERS, AND RHEOSTATS FOR OVERHEATING AND OIL-LEAKAGE. PAR. 47	
15	INSPECT METERS FOR DAMAGED GLASS AND CASES. PAR. 47		33	~~BEFORE SHIPPING OR STORING - REMOVE BATTERIES.~~	
16	~~INSPECT SHELTERS AND COVERS FOR ADEQUACY OF WEATHERPROOFING.~~		34	~~INSPECT CATHODE RAY TUBES FOR BURNT SCREEN SPOTS~~.	
17	~~CHECK ANTENNA GUY WIRES FOR LOOSENESS AND PROPER TENSION.~~		35	~~INSPECT BATTERIES FOR SHORTS AND DEAD CELLS.~~	
18	~~CHECK TERMINAL BOX COVERS FOR CRACKS, LEAKS, DAMAGED GASKETS, DIRT AND GREASE.~~		36	~~INSPECT FOR LEAKING WATERPROOF GASKETS, WORN OR LOOSE PARTS.~~	
			37	MOISTURE AND FUNGIPROOF. PAR 48	
38	IF DEFICIENCIES NOTED ARE NOT CORRECTED DURING INSPECTION, INDICATE ACTION TAKEN FOR CORRECTION. PAR. 46				

DA FORM 11-239, 1 MAY 51   REPLACES DA AGO FORM 419, 1 DEC 50, WHICH IS OBSOLETE.   ce—10—04382-1

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Figure 20. DA Form 11–239.

46. Use of Preventive Maintenance Forms
(figs. 19 and 20)

a. The decision as to which items on DA Forms 11–238 and 11–239 are applicable to Teletypewriter Test Set TS–611A/FG is a tactical decision to be made in the case of first echelon maintenance by the communication officer/chief or his designated representative, and, in the case of second and third echelon maintenance, by the individual making the inspection. Instructions for the use of each form appear on the reverse side of the form.

b. References in the ITEM column are paragraphs in text that contain additional information.

47. Performing Preventive Maintenance

Caution: Tighten screws, nuts, and bolts carefully. Fittings tightened beyond the pressure for which they were designed will be damaged or broken.

a. Exterior Items.

(1) Check for the completeness and the general condition of the equipment. The components are listed in paragraph 7.

(2) Remove dirt and moisture from the cabinet and front panels.

(3) Inspect the seating of the fuses, tubes, lamps, and relays.

(4) Inspect the controls for binding, scraping, excessive looseness, and for positive action.

(5) Check the equipment for normal operation (pars. 35 and 36).

(6) Clean and tighten panel mountings.

(7) Inspect the exposed metal surfaces of the equipment for rust and corrosion.

(8) Inspect the meters for broken glass.

(9) Inspect the polar relays for broken or frayed wiring, bent pins or springs, and loose screws.

(10) Inspect for looseness of relay covers, front panel covers, and components that are mounted on the front panels of the equipment.

(11) Inspect the capacitors for bulges or leaks.

(12) Inspect the transformers, coils, and resistors for signs of overheating.

Caution: Do not make any of the following checks with the power connected to the equipment. The power is disconnected from Teletypewriter Test Set TS–611A/FG when the rear door of the cabinet is opened.

b. Internal Items.

(1) Remove dirt and moisture from the components at the rear of the equipment.

(2) Inspect the seating of the tubes and relays.

(3) Clean and tighten the connections and mountings of transformers, relays, terminal boards, and other components.

(4) Inspect for looseness of the radiation shield.

(5) Visually inspect the wiring. Do not move or push the wiring unless a wire is suspected of being broken.

(6) Inspect the capacitors for leaks or bulges.

(7) Inspect the transformers, coils, and resistors for discoloration or other signs of overheating.

Section III. WEATHERPROOFING AND REFINISHING

48. Weatherproofing

a. General. Signal Corps equipment, when operated under severe climatic conditions such as prevail in tropical, arctic, and desert regions, requires special treatment and maintenance. Fungus growth, insects, dust, corrosion, salt spray, excessive moisture, and extreme temperatures are harmful to most materials.

b. Tropical Maintenance. A special moistureproofing and fungiproofing treatment has been devised which, if properly applied, provides a reasonable degree of protection. This treatment is explained in TB SIG 13, Moistureproofing and Fungiproofing Signal Corps Equipment, and TB SIG 72, Tropical Maintenance of Ground Signal Equipment. Since this treatment is not applied to Teletypewriter Test Set TS–611A/FG at the factory, it must be applied if the equipment is to be used in tropical climates.

c. Winter Maintenance. Special precautions necessary to prevent poor performance or total operational failure of equipment in extremely

low temperatures are explained in TB SIG 66, Winter Maintenance of Signal Equipment, and TB SIG 219, Operation of Signal Equipment at Low Temperatures.

d. Desert Maintenance. Special precautions necessary to prevent failure in areas subject to extremely high temperatures, low humidity, and excessive sand and dust are explained in TB SIG 75, Desert Maintenance of Ground Signal Equipment.

49. Rustproofing and Painting

a. When the finish of the cabinet has been badly scarred or damaged, rust and corrosion can be prevented by touching up bared surfaces with paint. Use No. 000 sandpaper to clean the surface down to the bare metal; obtain a bright smooth finish.

Caution: Do not use steel wool. Minute particles frequently enter the case and cause harmful internal shorting or grounding of circuits.

b. When a touchup job is necessary, apply paint with a small brush. Remove rust from the case by cleaning corroded metal with Cleaning Compound. In severe cases, it may be necessary to use Cleaning Compound to soften the rust and to use sandpaper to complete the preparation for painting. Paint used will be authorized and consistent with existing regulations.

Section IV. TROUBLESHOOTING AT ORGANIZATIONAL MAINTENANCE LEVEL

50. General

a. The troubleshooting and repair work that can be performed at the organizational level (operators and repairmen) is necessarily limited in scope by the tools, test equipment, and replaceable parts issued and by the existing tactical situation. Accordingly, troubleshooting is based on the performance of the equipment and the use of the senses in locating such troubles as burned-out fuses, broken wires or cords, defective tubes, cracked insulators, and so on.

b. This section contains information that helps determine which of the circuits is at fault and in localizing the trouble to a defective stage or item, such as a tube or fuse.

51. Visual Inspection

a. Failure of this equipment to operate properly may be caused by one or more of the following faults:

(1) Improperly connected power cords.
(2) Burned-out fuses.
(3) Worn, broken, or disconnected wiring.
(4) Dirty relay contacts or relays out of adjustment.
(5) Burned-out fuses.
(6) Shorted capacitors.
(7) Defective tubes.

b. When equipment failure is encountered, and the cause is not immediately apparent, visually check as many of the items as is practicable. Check to see if any components are bulging, burned, or charred. If possible, obtain information from the operator of the equipment regarding the performance at the time the trouble occurred.

52. Removal of Pluck-Out Parts

Fuses, tubes, and some relays are pluck-out parts in Teletypewriter Test Set TS–611A/FG. These parts and their locations on the equipment are listed in paragraph 16.

a. Fuses. Some fuses in Teletypewriter Test Set TS–611A/FG are mounted in cartridge-type fuse holders and others are mounted in the panel *power plugs.*

(1) To remove the fuses mounted in the cartridge-type fuse holders, turn the fuse-holder cap counterclockwise (about 1/8 turn) and pull it away from the equipment. The fuse is wedged in the fuse-holder cap.
(2) To remove the fuses mounted in the panel power plugs, use a piece of stiff wire and push the fuses out of the power plugs, toward the two flat blades of the power plugs.

b. Tubes. When removing tubes from the tube sockets, pull the tube straight out. Do not rock or attempt to rotate the tube in its socket. Rocking or rotating the tube causes the tube pins to bend and in some cases may cause the tube envelope to break away from the tube base. If a tube cannot be removed from its socket with a straightforward pull, use a tube puller.

c. Relays. Removable relays have a base that

is similar to the base that is used for electron tubes. To remove the relays without damaging the pins on the base, pull the relay straight out from the relay socket. Do not rock or rotate the relay.

53. Electron Tube Replacement Procedures

a. General. Before replacing electron tubes, proceed as follows:

(1) Inspect all cabling, connections, and the general condition of the equipment.

(2) If possible, isolate the trouble to a particular circuit or panel of the equipment.

(3) Remove and test one tube at a time if a tube tester is available.

(4) Use the tube substitution method (*b* below) if a tube tester is not available.

b. Tube Substitution Method.

(1) Replace the tubes suspected of being faulty, one at a time, with new tubes. Note the sockets from which the original tubes were removed. If the equipment becomes operative, discard the last tube removed.

Note. Some circuits, such as oscillator circuits, may function with one tube and not another even though both tubes are new. If practicable, keep any removed tube until its condition is checked with a suitable test instrument.

(2) Reinsert the remaining original tubes, one at a time, in the original sockets. If equipment failure occurs during this procedure, discard the last original tube that caused the equipment failure and replace it with the new tube. *Do not leave a new tube in a socket if the equipment operates satisfactorily with the original tube.*

(3) If there is an *insufficient* number of spares, substitute a new tube for the original tube. If the equipment continues to be inoperative, replace the new tube with the original tube. Similarly, check each original tube, in turn, until the equipment becomes operative. *Often it is possible to remove a tube from one circuit or section of the equipment without affecting the circuit or section being checked. In this case, troubleshoot the defective section using this tube as a spare.*

(4) If the tube substitution does not correct the trouble, reinsert the original tubes in their original sockets before forwarding the defective equipment for higher echelon repairs.

c. Conclusions.

(1) As a general rule, discard the tubes only when a tube tester or other instrument shows that the tube is defective or if the tube defects are obvious, as in the case of broken tube envelopes or pins or open filaments.

(2) Do not discard tubes merely because the tubes have been used for a specified length of time. Satisfactory operation in a circuit is the final proof of tube quality. The tube in use may work better than a new tube.

(3) Do not discard tubes merely because a check on a tube tester indicates that a tube *barely* meets minimum standards. It must be recognized that a certain percentage of new tubes fall near the low end of the acceptability range of the tube specification and, therefore, start their operational life at a value fairly close to the tube tester *retention limit.* These tubes may provide satisfactory performance throughout a long period of operational life at this *near limit* value.

54. Troubleshooting by Using Equipment Performance Checklist

a. General. The equipment performance checklist (par. 55) will help the operator to locate the trouble in the equipment. The list gives the item to be checked, the conditions under which the item is checked, the normal indications and tolerance of correct operation, and the corrective measures the operator can take. *To use this list, follow the items in numerical sequence.*

b. Action or Condition. For some items, the information given in the *Action or condition* column consists of various switch and control settings under which the item is to be checked. For other items, it represents an action that must be taken to check the normal indication given in the *normal indications* column.

c. Normal Indications. The normal indications include the visible and audible signs that the operator should perceive when the items are checked. If the indications are not normal, apply the recommended corrective measures.

d. Corrective Measures. The corrective measures listed are those the operator can make without performing field maintenance repairs. If the set is completely inoperative, or if the recommended corrective measures do not yield results, troubleshooting at a higher level of maintenance is necessary.

55. Equipment Performance Checklist

The equipment performance checklist below is prepared for checking equipment performance when the teletypewriter test set is to be used for testing 60-wpm, 60-ma, 5-unit code, neutral transmission. Equipment performance for other types of transmission is similar (pars. 31–36).

	Item No.	Item	Action or condition	Normal indications	Corrective measures
PREPARATORY	1	Power switch	Set to OFF position.		
	2	Jacks	Remove all plugs from jacks.		
	3	CHG SPD switch	Set to unoperated position (white line horizontal).		
	4	.020A switch	Set to unoperated position (white line horizontal).		
	5	POL switch	Set to unoperated position (white line horizontal).		
	6	SPEED switch	Set to position 75.		
	7	SIGS switch	Set to unoperated position (arrow pointing upward).		
	8	ADJ SPD switch	Set to unoperated position (white line horizontal).		
	9	BIAS, CONST CUR, and SC-REF volt meters.	Check position of meter needle.	Meter needle rests at 0	Turn meter zero-adjustment screw until meter needle rests at 0. If proper adjustment cannot be obtained, repairs at field maintenance level are required.
	10	TOTAL DIST meter	Check position of meter needle.	Meter needle rests at −5	Turn meter zero-adjustment screw until meter needle rests at −5. If proper adjustment cannot be obtained, repairs at field maintenance level are required.
	11	Interunit connections and wiring options.	Check all interunit connections and optional wiring (pars. 18 and 19).	Wires connected to proper terminals and soldered properly.	Reconnect wires correctly and resolder if necessary.
	12	Panel connections	Insert panel power plugs into outlets on the power connection assembly (par. 23).		
	13	Ground connection	Check ground connection (par. 24).	Ground wire properly terminated and soldered.	Improve the ground connection if necessary.
	14	External power connections.	Check external power connections (par. 25).	Wires properly connected, fused, and soldered.	Reconnect wires correctly, fuse, and resolder if necessary.
	15	Rear door of teletypewriter test set cabinet.	Close the cabinet door and secure it by turning the cabinet door handle (interlock).		

	Item No.	Item	Action or condition	Normal indications	Corrective measures
START	16	Power switch	Set to ON position (allow the teletypewriter test set to warm up for about 5 minutes).	Vacuum-tube filaments should light and a pale blue glow should be present in rectifier tubes.	Replace vacuum tubes that have filaments which do not light and rectifier tubes which do not glow (blue). Check all fuses (par. 16). If none of the tubes light, troubleshooting at field maintenance level is required.
EQUIPMENT PERFORMANCE	17	Power supplies	Measure output voltages (par. 29).	+130 volts dc for REG TUBE RECT +TG panel, −130 volts for REG TUBE RECT −TG panel, and +24 volts dc for 24 VOLT SUP panel.	Adjust potentiometers R and resistor R601 to obtain the proper voltages (par. 29). Check tubes and fuses on REG TUBE RECT panels and check fuses on 24 VOLT SUP panel. If proper output voltages cannot be obtained, troubleshooting at field maintenance level is required.
	18	CODE switch	Set the switch so that the arrow on the switch control points to 5.		
	19	SIGS switch	Set the switch so that the arrow on the switch control points to the left.		
	20	BSY lamps	Insert a patch cord plug into the TMS IN jack.	BSY lamps at all extension units should light.	Replace any lamp that does not light. If the lamp still does not light or if all lamps do not light, troubleshooting at field maintenance level is required.
	21	Constant current supply	Check position of meter needle on CONST CUR meter.	Meter needle rests on 30	Adjust CONST CUR potentiometer until the meter needle rests on 30. Check tubes and fuses on PWR SUP panel. If proper adjustment still cannot be obtained, troubleshooting at field maintenance level is required.
	22	Stop compensating voltage.	Check position of meter needle on SC-REF VOLT meter.	Meter needle rests on 55	Adjust SC VOLT potentiometer until the meter needle rests on 55. Check tubes and fuses on PWR SUP panel. If proper adjustment still cannot be obtained, troubleshooting at field maintenance level is required.

EQUIPMENT PERFORMANCE

Item No.	Item	Action or condition	Normal indications	Corrective measures
23	Reference voltage	Depress REF VOLT switch and check position of meter needle on SC–REF VOLT meter.	Meter needle rests on 55	Adjust REF VOLT potentiometer until the meter needle rests on 55. Check tubes and fuses on PWR SUP panel. If proper adjustment still cannot be obtained, troubleshooting at field maintenance level is required.
24	Constant current supply, stop compensating voltage, and reference voltage.	Repeat items 21, 22 and 23. Readjust, if necessary.		
25	TOTAL DIST meter	Turn AMP ADJ potentiometer to extreme clockwise position. Set CHAR potentiometer at the middle of its limits of adjustment. Momentarily depress RESET switch.	Meter needle on TOTAL DIST meter points to −5 when RESET switch is depressed.	Adjust the ZERO ADJ potentiometer until the meter needle points to −5. When the reset switch is depressed. Check tubes V303 and V304 and fuses on RECT PEAK VM panel. If proper adjustment cannot be obtained, troubleshooting at field maintenance level is required.
26	SIGS switch	Set the switch so that the arrow on the switch control points upward.		
27	BIAS meter	Patch 60-wpm, 60-ma, 5-unit code, neutral-type, distortion-free test signals to the TMS IN jack. Depress the CAL switch and keep it depressed.	Meter reading averages S15.	Adjust the BIAS potentiometer until the meter reading averages S15. Replace polar relay K2, K4, and K5. If proper adjustment cannot be obtained, troubleshooting at field maintenance level is required.
28	TOTAL DIST meter	Operate RESET switch several times.	Meter reading rises to 10	Adjust the AMP ADJ potentiometer, while repeatedly operating the RESET switch, until the meter reading rises to 10. Check tubes V301 and V302 on the RECT PEAK VM panel. If proper adjustment still cannot be made, troubleshooting at field maintenance level is required.
29	BIAS meter	Depress REV CAL switch and keep it depressed.	Meter reading averages S15.	Troubleshooting at field maintenance level is required if this meter reading cannot be obtained.
30	TOTAL DIST meter	Depress RESET switch momentarily.	Meter reading should rise to 10.	If the meter reading is less than 9 or more than 10, check rectifier tubes V301 and V302. If the reading still cannot be obtained, troubleshooting at field maintenance level is required.

Item No.	Item	Action or condition	Normal indications	Corrective measures
31	CAL and REV CAL switches.	Release the switches (items 27 and 29).		
32	BIAS meter	Set ADJ SPD switch so that the white line on the switch control is vertical.	Meter reading should be 0	Adjust the COARSE 60 and FINE 60 switches to obtain a meter reading that is closest to 0. If a near-zero meter reading cannot be obtained, troubleshooting at field maintenance level is required.
33	ADJ SPD switch	Set the switch so that the white line on the switch control is horizontal.		
34	TOTAL DIST meter	Turn DECR 60 potentiometer counterclockwise to its lowest setting. Depress ADJ DECR switch and keep it depressed. Depress RESET switch momentarily. Make a note of the reading on the total DIST meter.		
35	TOTAL DIST meter	Set the SIGS switch so that the arrow on the switch control is pointed to the right. Depress RESET switch momentarily.	Meter reading should be the same as the meter reading obtained in item 34.	Adjust the DECR 60 potentiometer until the reading obtained is the same as the reading obtained in item 34. Check tube V203 on the DISTRIBUTOR panel. Check tube V301 on the RECT PEAK VM panel. Replace relay K3.
36	ADJ DECR and SIGS switches.	Release ADJ DECR switch (item 34) and set the SIGS switch so that the arrow on the switch control is pointed upward.		
37	BIAS meter	Depress M-S only switch	Meter reading should be 0	Adjust the ORIENT 60 potentiometer until the reading is obtained. If this meter reading cannot be obtained, troubleshooting at field maintenance level is required.
38	BIAS meter	Release M-S ONLY switch (item 37).	Meter reading should be ±1 percent.	Troubleshooting at field maintenance level is required if this meter reading is not obtained.
39	TOTAL DIST meter	Depress RESET switch momentarily.	Meter reading should be between −2 percent and −5 percent.	A meter reading above −2 percent indicates excessive internal distortion and this should be removed by checking the relays of the teletypewriter test set before proceeding further.

	Item No.	Item	Action or condition	Normal indications	Corrective measures
EQUIPMENT PERFORMANCE	40	TOTAL DIST meter	Depress M-S ONLY switch.	Meter reading should be 0	Turn ZERO ADJ potentiometer until meter reading is obtained. If proper adjustment cannot be made, troubleshooting at field maintenance level is required.
	41	M-S ONLY switch	Release M-S ONLY switch (item 40).		
	42	BIAS and TOTAL DIST meters.	Transmit 60-wpm, 60-ma, 5-unit code, neutral-type test signals with known marking bias distortion.	BIAS meter reading should be equal to the known marking bias of the test signals (±2 percent). TOTAL DIST meter reading should be numerically equal to the BIAS meter reading.	Recheck all previous adjustments and measurements. If normal indications still cannot be obtained, troubleshooting at field maintenance level is required.
	43	BIAS and TOTAL DIST meters.	Transmit 60-wpm, 60-ma, 5-unit code, neutral-type test signals with known spacing bias distortion.	BIAS meter reading should be equal to the known spacing bias of the test signals (±2 percent). TOTAL DIST meter reading should be numerically equal to the BIAS meter reading.	Recheck all previous adjustments and measurements. If normal indications still cannot be obtained, troubleshooting at field maintenance level is required.
	44	BSY lamps	Remove patch cord from TMS IN jack.	BSY lamps at extension units will be unlighted (item 20).	
STOP	45	Power switch	Set to OFF position	Tube filaments will not be lighted. All meter needles should indicate 0 except the TOTAL DIST meter needle which should indicate −5.	

CHAPTER 5
THEORY

Section I. ANALYSIS OF OPERATING PRINCIPLES

56. General

Teletypewriter Test Set TS–611A/FG measures the displacement of transitions in teletypewriter signals from their proper position in the signal combination. The initial transition of the start pulse of a character is used as a reference. The method used to determine the amount of displacement of transitions is based on the translation of displacements into voltages across capacitors, which are charged at a constant rate during the time intervals to be measured, and on the comparison of these voltages with an accurate reference voltage. The reference voltage is equal to the voltage that should be developed across the capacitor if the transition occurs at the proper time. The charging intervals are started at the correct time, with respect to the start pulse, by an electronic distributor. The occurrence of transitions in the teletypewriter signal determines the length of the charging interval and also the exact instant that the voltage developed across the capacitor is compared with the reference voltage. If no distortion is present, there is no displacement of transitions and the voltage applied across the capacitor is equal to the reference voltage; the meters of the teletypewriter test set, therefore, will indicate zero distortion. If distortion is present, the transition will not occur at the proper time and the voltage developed across the capacitor will not be equal to the reference voltage; the meters of the teletypewriter test set, therefore, will indicate the type of distortion in the signals.

57. Measurements by Capacitor-Charging Principle

A capacitor-charging principle is used in the measuring circuit of the teletypewriter test set for accurate distortion measurements of teletypewriter signals. An analysis of this principle will help the user of the teletypewriter test set understand its principles of operation. To simplify the explanation of the capacitor-charging principle, simplified distributor and comparison circuits will be used (fig. 21). Actual circuitry involved is more complicated and will be presented in other parts of this chapter. Although the teletypewriter test set contains an electronic distributor, a mechanical distributor is used in this explanation to simplify the switching operations involved.

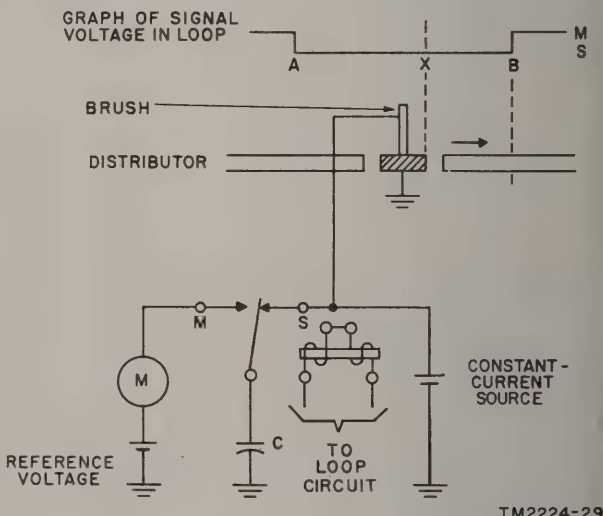

Figure 21. Distributor and comparison circuits, simplified schematic diagram.

a. Assume that the brush of the mechanical distributor in figure 21 is released at transition A (mark-to-space), moves to the right as indicated by the arrow, passes over the grounded segment (cross-hatched), and discharges measuring capacitor C. During the time when the

brush leaves the grounded segment (point X on the graph) and transition B occurs (space-to-mark), capacitor C is charged by a constant-current source.

b. The voltage developed across the capacitor can be defined as $E = IT/C$, where E is the voltage developed across the capacitor, I is the current that is charging the capacitor, T is the time of the capacitor-charging interval, and C is the capacitance value of the capacitor. In this case, I and C are constant; therefore, the voltage developed across the capacitor depends directly on the time interval that the capacitor is being charged. The voltage across the capacitor is thus directly proportional to the elapsed charging time.

c. When the space-to-mark transition occurs at point B, the relay armature operates to spring contact M and capacitor C is connected to a reference voltage through meter M. If the voltage across capacitor C is equal to the reference voltage, no current flows through meter M. This will be true if transition B occurs at t' correct instant, with respect to the time that the brush moves off the grounded segment. If signal distortion is present and transition B occurs too early or too late, the voltage developed across capacitor C will be smaller or greater than the reference voltage; as a result, a small current will flow through meter M during the interim period when capacitor C is connected to the reference voltage. Meter M will then indicate the presence of distortion, and the direction of the meter needle deflection will indicate whether the charging interval is shorter or longer than it should be. Because the charging rate is constant, the magnitude of distortion is indicated by the amount of meter deflection.

58. Description of Measuring Circuit Operation

A simplified schematic diagram of the distributor and measuring or comparison circuit of the teletypewriter test set is shown at D, figure 22. To simplify explanation, the measuring circuit is shown connected to a mechanical distributor although an *electronic* distributor is actually used in the teletypewriter test set. Curves representing a distortion-free teletypewriter character and voltages for measuring the capacitors are shown at A, B, and C, figure 22. The heavy slanting lines of curves B and C indicate the capacitor-charging intervals (during transitions), which are necessary for measurements. The cross-hatched segments of the mechanical distributor (1–7 in D, fig. 22) provide the capacitor grounding intervals. They are spaced one unit apart. The vertical dashed lines above each cross-hatched segment are provided to enable the reader to integrate the information in curves A, B, and C with the circuit functions explained in *a* through *h* below.

a. Assume that a distortion-free teletypewriter character (A, fig. 22) is applied to relays K4 and K5 and that it consists of a *stop* pulse (mark), a *start* pulse (space), and five *selecting* pulses (mark or space, numbered 1–5). Assume, also, that the capacitor grounding segments (1–7 in D, fig. 22) are so placed with respect to the start pulse of this teletypewriter character that with a perfect signal, the grounding intervals occur at a midpoint between the space-to-mark and mark-to-space transitions (a–f in A, fig. 22).

b. When no teletypewriter signals are applied to relays K4 and K5 (D, fig. 22), the brush of the distributor rests on the *stop* segment. A 55-volt potential is connected to capacitors C208 and C209 through the stop segment and spring contact M of relay K4. When a mark-to-space transition occurs at the beginning of the start pulse (point a of A, fig. 22) the armatures of relays K4 and K5 operate to spring contacts S. At the same instant, the distributor brush moves in the direction of the arrow over the segments of the distributor. The distributor furnishes exact timing for the capacitor grounding intervals. Operation of relay K4 to spring contact S connects capacitors C208 and C209 to the reference voltage through resistor R16A, which is in parallel with the bias meter circuit and resistor R16B, and the primary winding in the rectifying peak voltmeter. Because the voltage on capacitors C208 and C209 equals the *stop compensating voltage,* which in turn is adjusted to equal the reference voltage, no current flows through the bias or total distortion meter circuits. Capacitors C210 and C211 are connected to the stop compensating voltage through operated spring contacts of relay K5. At the midpoint of the start pulse, the brush passes across the first grounding segment and discharges capacitors C210 and C211. When the brush moves off the grounding seg-

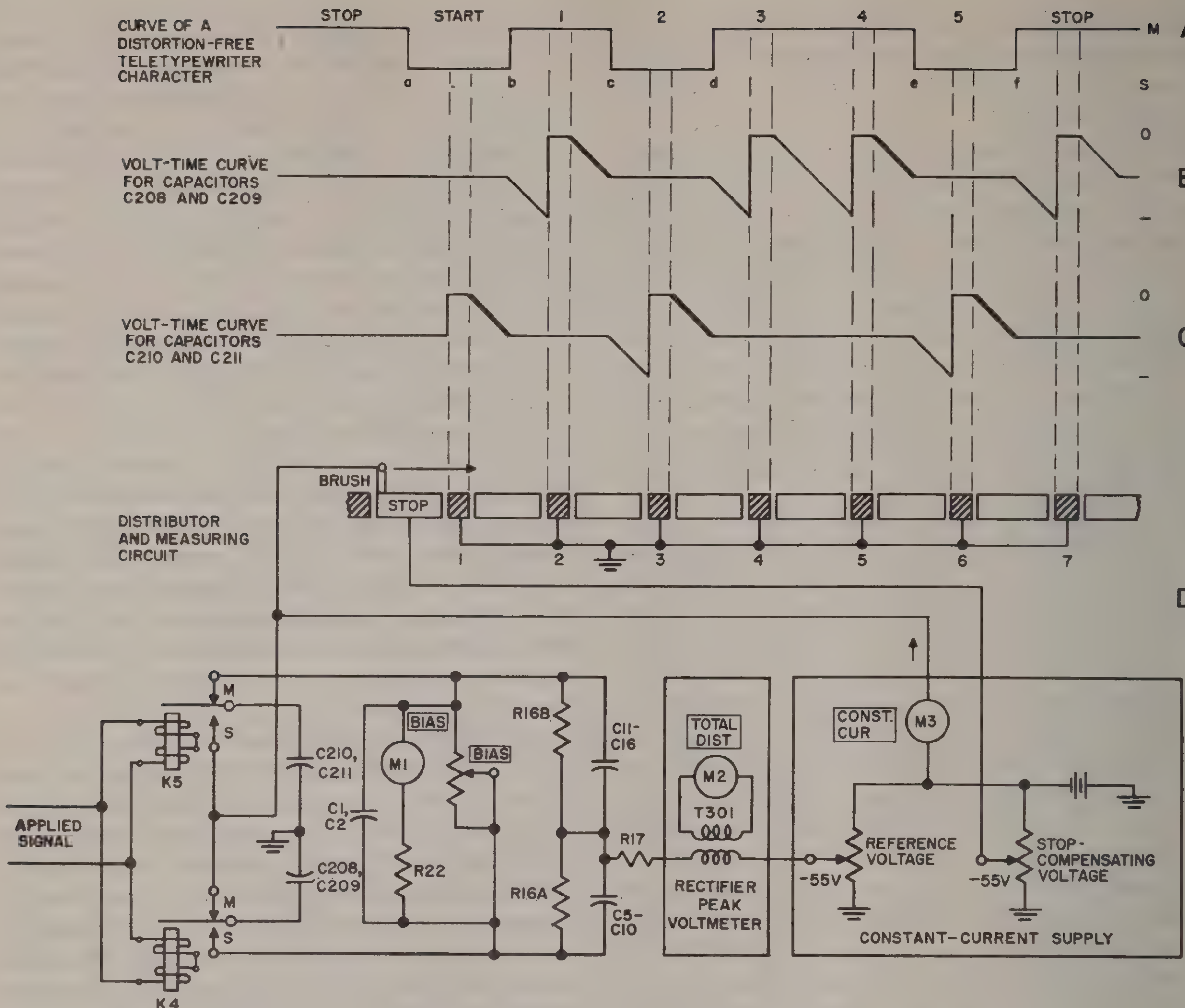

Figure 22. Transmission measuring circuit, simplified schematic diagram.

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ment, capacitors C210 and C211 start charging from the *constant-current supply.* The voltage on capacitors C210 and C211 increases at a constant rate until the end of the start pulse (point b in A, fig. 22). At this point, a space-to-mark transition takes place and armatures of relays K4 and K5 operate to spring contacts M.

c. When relay K5 operates, the voltage on capacitors C210 and C211 is compared with the *reference voltage.* The circuit is from capacitors C210 and C211, through contact M of relay K5, through a parallel circuit that consists of resistor R16B and the bias meter circuit, which is in series with resistor R16A, through resistor R17 and the primary of the rectifying peak voltmeter, to the reference voltage. It is assumed that undistorted signals were applied, resulting in a correct capacitor charging interval; therefore, the voltage on capacitors C210 and C211 is equal to that of the reference voltage and no current flows through the BIAS and TOTAL DIST meters. If the incoming signal is distorted, causing the transition to occur too soon, the capacitor-charging interval is too short and the voltage on capacitors C210 and C211 is therefore less negative than the reference voltage. Current thus flows from the capacitors, through the meters, to the reference voltage supply. This current flow causes the BIAS meter to indicate a marking bias, proportional to the distortion of the incoming signal. If the transition occurs later than it should, the capacitor-charging interval is too long and the voltage appearing across the capacitors C210 and C211 is more negative than the reference voltage. Current thus flows

from the reference voltage supply, through the meters, to the capacitors and the BIAS meter indicates a spacing bias.

d. When the transition from space-to-mark occurs (point b in A, fig. 22), relay K4 connects capacitors C208 and C209 to the constant current supply. The first part of the cycle forms no useful purpose because when the brush reaches the second grounded segment, capacitors C208 and C209 discharge. When the brush leaves the grounded segment, capacitors C208 and C209 begin to charge again from the constant-current supply and the capacitor voltage increases at a constant rate, until the mark-to-space transition occurs at the beginning of the second selecting pulse (point c in A, fig. 22). At this point, relays K4 and K5 operate to spring contacts S.

e. Operation of relay K4 causes the voltage on capacitors C208 and C209 to be compared with the reference voltage. If there is no distortion, the voltage on capacitors C208 and C209 is equal to the reference voltage and no current flows through the BIAS and TOTAL DIST meters. If, however, distortion causes the transition to occur too soon, the voltage on capacitors C208 and C209 is less negative than the reference voltage, and current flows from the capacitors, through the meters, to the reference voltage supply. The amount of current flow is proportional to the distortion. If the transition occurs later than it should, the voltage on capacitors C208 and C209 is more negative than the reference voltage and current flows from the reference voltage, through the meters, to the capacitors; the amount of current being proportional to the distortion. Thus, in either case, the indicating meters are affected. The current flow through the BIAS meter is in a direction opposite to that described in *c* above, therefore, if the capacitor grounding interval is too short, the BIAS meter indicates a marking bias. Because the TOTAL DIST meter is included in a rectifying circuit (details not shown in fig. 22), the meter needle always deflects in the same direction.

f. Operation of relay K5, in response to the transition from mark-to-space at the beginning of the second selecting pulse (point c in A, fig. 22), connects capacitors C210 and C211 to the constant-current supply. The operation described in *e* above is repeated except that now capacitors C210 and C211 are used. This same action is repeated for each space-to-mark or mark-to-space transition with capacitors C210 and C211 or capacitors C208 and C209, respectively, being used in the measurement.

g. Curve B (fig. 22) shows the voltage changes across capacitors C208 and C209, and curve C shows the voltage changes across capacitors C210 and C211. Note that ground, which is zero potential, is associated with the uppermost point on the curves, and a negative voltage is associated with the lower points on the curves. The heavy lines on the curves indicate the charging intervals used during the measurement of distortion. Note also that on curve B, the useful intervals occur during selecting pulses 1 and 4; on curve C, the useful intervals occur during the start pulse and selecting pulses 2 and 5. Selecting pulse 3 is not measured because the armature contacts of relays K4 and K5 do not change their positions between selecting intervals 3 and 4. Thus the time interval for charging capacitors C208 and C209 begins when the brush leaves grounding segment 5, which discharges capacitors C208 and C209.

h. The BIAS meter movement is damped by capacitors C1 and C2, which are placed across the meter to provide an average distortion reading. Capacitors C5 through C16, bridged across resistors R16A and R16B, perform a similar function.

Section II. BLOCK DIAGRAM

59. General

The complete circuit of the teletypewriter test set can be divided into several parts to simplify analysis. In figure 23, these parts are represented as blocks, which are divided into three categories (A, B, and C). The blocks associated primarily with the *measurement of distortion* in teletypewriter signals appear in A, figure 23; those associated with *dc power distribution* appear in B, figure 23; and the one associated with *ac power distribution* appears in C, figure 23. The circuits, represented by each of the blocks, are explained briefly in paragraphs 60 through 67. Paragraphs in other sections of this chapter describe these circuits in more detail.

60. Input Circuits
(A, fig. 23)

Teletypewriter circuits having test jack appearances that are close to the teletypewriter test set can be *patched* directly to its receiving relay circuit. Teletypewriter circuits having test jack appearances that are not close to the teletypewriter test set can be connected to its receiving relay circuit by an alternate path, which includes extension units, interconnecting wiring, and extension relay circuits.

61. Extension Unit Circuits
(A, fig. 23)

Extension units are used with the teletypewriter test set to provide remote appearances for its input circuit. Normally, only five extension units are provided with each teletypewriter test set but wiring is provided for use with a maximum of 15. Use of extension units provides a means of testing teletypewriter circuits that have test jack appearances on test boards or patch boards that are not in the vicinity of the teletypewriter test set (as in a large central office).

62. Measuring Circuit
(A, fig. 23)

Teletypewriter signals that appear in the receiving relay circuit are directed to the comparison circuit where the capacitor-charging principle (pars. 56–58) is used to detect the type and amount of distortion. The BIAS meter and the TOTAL DIST meter provide visual indications of the distortion.

63. Distributor Circuit
(A, fig. 23)

Teletypewriter signals that appear at the receiving relay circuit are directed to the distributor circuit where the functions of the character timer, pulse oscillator, detector, and capacitor-discharging circuits are integrated to provide the proper electronic timing and switching necessary for the proper operation of the measuring circuit. Signals that appear at the receiving relay circuit are also directed to the measuring circuit where they control the operation of polar relays in the comparison circuit.

64. Power Supply Circuit
(A, fig. 23)

Proper operation of the measuring circuit depends upon a constant-current supply, which is used for charging capacitors in the comparison circuit, and a source of reference voltage that is used as a standard against which the voltage developed across the capacitors can be compared. Proper operation of the measuring circuit also depends upon a source of stop-compensating voltage, which is applied to its measuring capacitors by distributor circuit switching action during the stop pulse of a teletypewriter character. Use of the stop-compensating voltage prevents incorrect meter indications when the distributor circuit provides the necessary switching operations at the start of any teletypewriter character.

65. Regulated 130-Volt Dc Power Supply Circuits
(B, fig. 23)

Two regulated tube rectifier circuits are provided in the teletypewriter test set. One rectifier circuit provides regulated +130 volts dc; the other, —130 volts dc. The rectifiers supply dc operating voltages for the polar relays and also plate voltage for some tubes. Ac (60 cps) voltage from both regulated tube rectifiers is supplied to a 24-volt dc power supply (par. 66).

66. Power Supply Circuit, 24-Volt
(B, fig. 23)

The 24-volt power supply circuit provides dc operating voltage for the neutral-type relays in the input circuit, the distributor circuit, and the measuring circuit. It also provides dc voltage for the supervisory lamps. Ac input power for the 24-volt dc supply circuit is received from the regulated 130-volt dc power supply circuits.

67. Ac Power Distribution Circuit
(C, fig. 23)

The ac power distribution circuit distributes 115-volt, 60-cps power in the teletypewriter test set. Power plugs are provided on the panels of the distributor circuit, the power supply circuit, the rectifying peak voltmeter circuit, and the two regulated 130-volt, dc power supply circuits to permit connections to the outlets of the ac power distribution circuit. A microswitch is provided at the input of the ac power distribution circuit that automatically disconnects all power from the teletypewriter test set when the rear door of the teletypewriter test set is opened for inspection or maintenance.

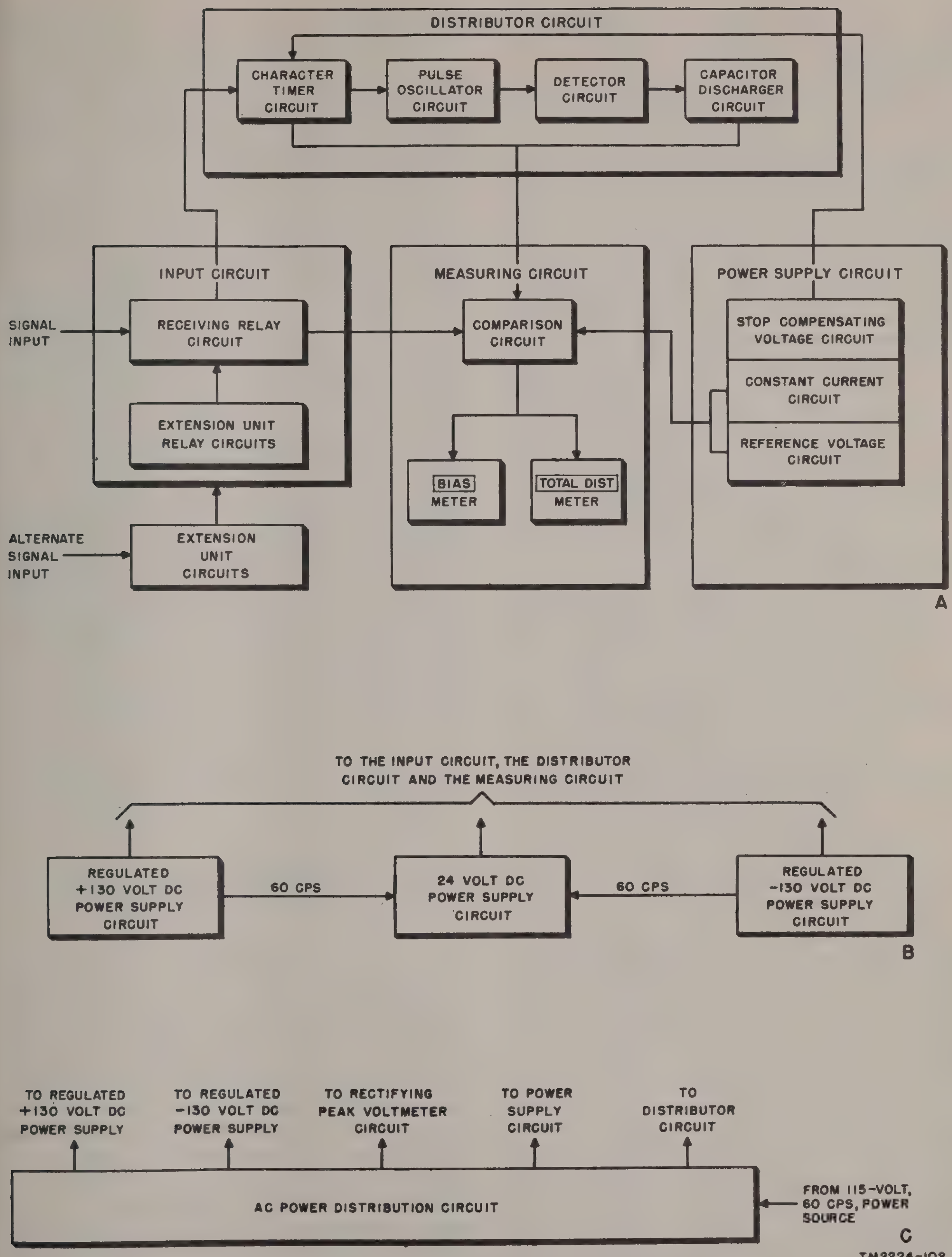


Figure 23. Teletypewriter Test Set TS-611A/FG, block diagram.

68. General

a. This section explains the functions of the receiving relay circuits of the teletypewriter test set. The receiving relay circuits can be arranged for use with any one of the three common types of teletypewriter circuit operation (60 ma neutral, 20 ma neutral, or polar). The functions of the receiving relay circuits are essentially the same whether a teletypewriter circuit is patched to the teletypewriter test set or to one of its extension units. The only differences are as follows:

(1) At the teletypewriter test set, the operator must use the .020A or the POL switch to arrange the receiving relay circuits for a particular type of operation. At the extension unit, the operator must use the POL – .060A–.020A switch to arrange the receiving relay circuits for a particular type of operation.

(2) Relay K11 is used in the receiving circuit if a teletypewriter circuit is patched to the TMS IN jack at the teletypewriter test set. The chart below indicates the relay that is automatically substituted for relay K11, and that will perform the same function in the receiving relay circuits, if a teletypewriter circuit is patched to the TMS IN jack at any one of the extension units. The relays listed in the chart are part of the extension unit relay circuits (fig. 23).

Extension unit used	Relay substituted for relay K11
1	K16.
2	K18.
3	K20.
4	K22.
5	K24.
6	K26.
7	K28.
8	K30.
9	K32.
10	K34.
11	K36.
12	K38.
13	K40.
14	K42.
15	K44.

b. A simplified schematic diagram (fig. 24) is used to supplement the explanation of the receiving relay circuits; however, these circuits (with more detail) also appear on a partial schematic diagram (fig. 25) and on the overall schematic diagram (fig. 73).

c. When the teletypewriter test set is patched to a teletypewriter circuit that is to be tested, the patch cord must first be plugged into the TMS IN jack of the teletypewriter test set and then into the test jack for the teletypewriter circuit. When the teletypewriter test set is being disconnected from the teletypewriter circuit, the patch cord must first be removed from the test jack for the teletypewriter circuit and then from the TMS IN jack of the teletypewriter test set. This procedure prevents a momentary *open* in the circuit that is to be tested. For this reason and also to further simplify the explanation of the receiving relay circuits, the circuit explanations in paragraphs 69 through 71 are divided into three subparagraphs. The function of the receiving relay circuits when the teletypewriter test set is idle is described in *a.* The function of the receiving relay circuits when the plug on one end of a patch cord is inserted into a TMS IN jack as described in *b.* The function of the receiving relay circuits when the plug on the other end of the patch cord is inserted into the test jack of a teletypewriter circuit as described in paragraph *c.*

69. Receiving Relay Circuit Arranged for 60 Ma Neutral Operation
(fig. 24)

a. When the teletypewriter test set is idle (no teletypewriter circuit patched to the TMS IN jack), approximately 30 ma of current are present in winding 7–2 of relay K2 and approximately 60 ma of current are present in winding 6–3. The polarity of the voltages applied to these windings is such that the current in winding 7–2 creates a magnetic field, which tends to operate the armature of relay K2 to contact 5 (space contact). The current in winding 6–3 creates a magnetic field, which tends to operate the armature of relay K2 to contact 4 (mark contact). The magnetic field created by the 60 ma of current in winding 6–3 is stronger than the magnetic field created by

the 30 ma of current in winding 7–2; therefore, the armature of relay K2 is operated to contact 4.

(1) The circuit for the current in winding 7–2 of relay K2 can be traced from the +130-volt supply, through contacts 2B and 1B of relay K8, through contacts 3T and 2T of relay K9, through winding 7–2 of relay K2, through contacts 2B and 3B of relay K9, through contacts 1T and 2T of relay K8, through resistors R13 and R12 to the —130-volt supply.

(2) The circuit for the current in winding 6–3 of relay K2 can be traced from the —24-volt supply, through resistor R18, through contacts 5T and 6T of relay K10, through winding 6–3 of relay K2, through contacts 6B and 5B of relay K10, to ground.

b. When the plug of a patch cord is inserted into the TMS IN jack, a circuit is completed from a grounded contact on the TMS IN jack, through the winding of relay K11, to the —24-volt supply, and relay K11 operates.

(1) Relay K11 completes a circuit from the —24-volt supply, through contacts 9B and 8B, through the winding of relay K10 to ground, and relay K10 operates.

(2) Relay K11 removes the shunts from the tip and the sleeve of the TMS IN jack when relay contacts 1T and 3T and relay contacts 1B and 3B open.

(3) Relay K11 completes a circuit from the tip and the sleeve of the TMS IN jack to contacts 1T and 3B and contacts 1B and 3T, respectively, of relay K10.

(4) Relay K10 removes the shunts from the tip and the sleeve of the TMS IN jack when relay contacts 1T and 3T and relay contacts 1B and 3B open.

(5) Relay K10 opens the circuit from winding 6–3 of relay K2 to the —24-volt supply at relay contact 6T and to the ground at relay contact 6B.

(6) Relay K10 completes a circuit from the tip and the sleeve of the TMS IN jack to winding 6–3 of relay K2. This circuit can be traced from the tip contact of the TMS IN jack, through contacts 1T and 2T of relay K11, through contacts 1T and 2T of relay K10, through winding 6–3 of relay K2, through contacts 2B and 1B of relay K10, through contacts 2B and 1B of relay K11, to the sleeve contact of the TMS IN jack.

(7) Because there is no current present in winding 6–3 of relay K2 and there is 30 ma of current present in winding 7–2 (*a*(1) above), the armature of relay K2 is operated to contact 5.

c. When the plug on the other end of the patch cord is inserted into the test jack for the teletypewriter circuit that is to be tested, winding 6–3 of relay K2 is placed in series with the teletypewriter circuit.

(1) Because 60 ma neutral operation is assumed for the teletypewriter circuit, 60 ma of current will be present in winding 6–3 of relay K2 whenever the teletypewriter circuit is idle or transmitting mark signals and the armature of relay K2 will be operated to contact 4.

(2) When the teletypewriter circuit is transmitting space signals, no current will be present in winding 6–3 of relay K2 and the 30 ma of current present in winding 7–2 will cause the armature to operate to contact 5.

70. Receiving Relay Circuit Arranged for 20 Ma Neutral Operation
(fig. 24)

The .020A switch must be operated when the receiving relay circuit of the teletypewriter test set is arranged for 20 ma neutral operation.

a. When the teletypewriter test set is idle (no teletypewriter circuit patched to the TMS IN jack), approximately 30 ma of current are present in winding 7–2 of relay K2 and approximately 60 ma of current are present in winding 6–3. The polarity of the voltages applied to these windings is such that the current in winding 7–2 creates a magnetic field, which tends to operate the armature of relay K2 to contact 5 (space contact). The current in winding 6–3 creates a magnetic field, which tends to operate the armature of relay K2 to contact 4 (mark contact). The magnetic field created by the 60 ma of current in winding 6–3 is stronger than the magnetic field created by the 30 ma of current in winding 7–2; therefore

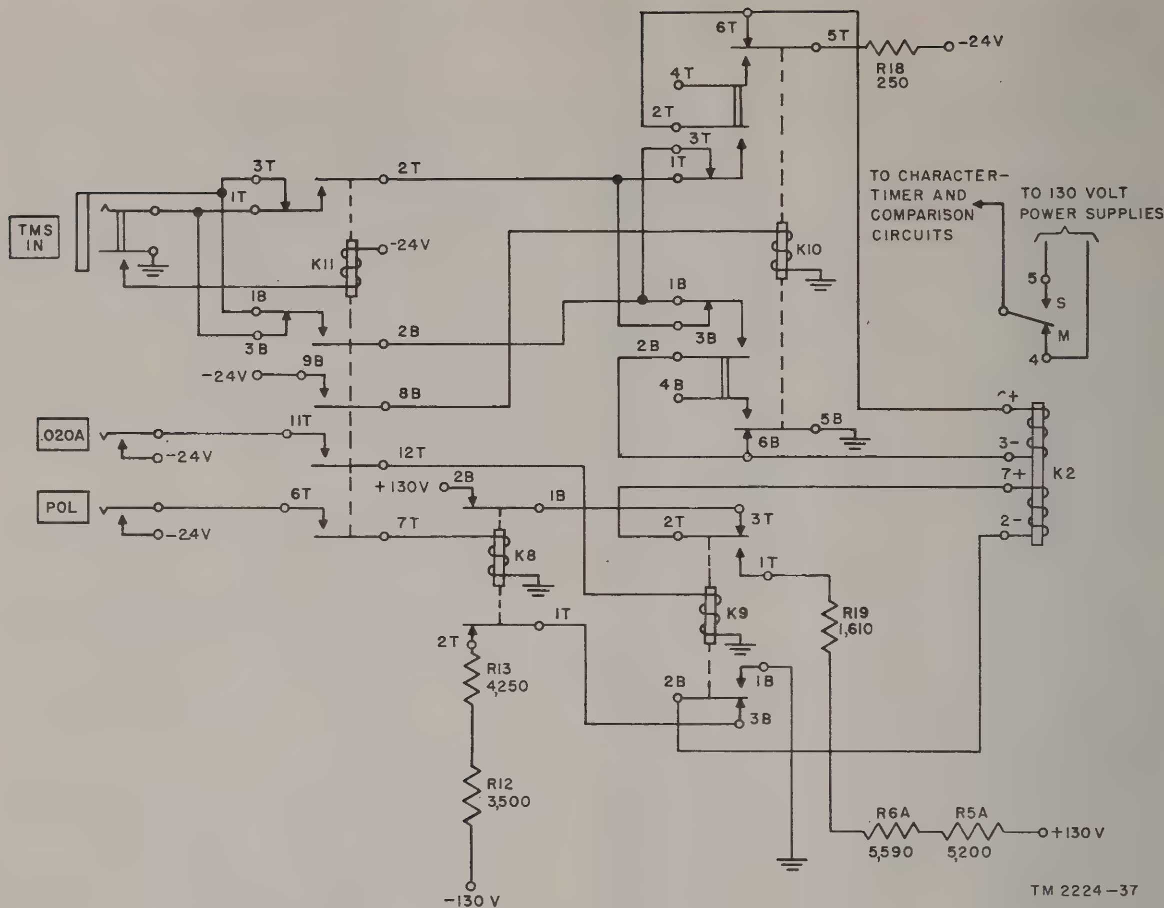


Figure 24. Receiving relay circuit, simplified schematic diagram.

the armature of relay K2 is operated to contact 4.

(1) The circuit for the current in winding 7–2 of relay K2 can be traced from the +130-volt supply, through contacts 2B and 1B of relay K8, through contacts 3T and 2T of relay K9, through winding 7–2 of relay K2, through contacts 2B and 3B of relay K9, through contacts 1T and 2T of relay K8, through resistors R13 and R12 to the —130-volt supply.

(2) The circuit for the current in winding 6–3 of relay K2 can be traced from the —24-volt supply, through resistor R18, through contacts 5T and 6T of relay K10, through winding 6–3 of relay K2, through contacts 6B and 5B of relay K10, to ground.

b. When the plug of a patch cord is inserted into the TMS IN jack, a circuit is completed from a grounded contact on the TMS IN jack, through the winding of relay K11, to the —24-volt supply, and relay K11 operates.

(1) Relay K11 completes a circuit from the —24-volt supply, through contacts 9B and 8B, through the winding of relay K10, to ground, and relay K10 operates.

(2) Relay K11 completes a circuit from the —24-volt supply at the closed contacts of the .020A switch, through contacts 11T and 12T of relay K11, through the winding of relay K9, to ground, and relay K9 operates.

(3) Relay K11 removes the shunts from the tip and the sleeve of the TMS IN jack when relay contacts 1T and 3T and relay contacts 1B and 3B open.

(4) Relay K11 completes a circuit from the tip and the sleeve of the TMS IN jack to contacts 1T and 3B and contacts 1B and 3T, respectively, of relay K10.

(5) Relay K10 removes the shunts from the tip and the sleeve of the TMS IN jack when relay contacts 1T and 3T and relay contacts 1B and 3B open.

(6) Relay K10 opens the circuit from winding 6–3 of relay K2 to the —24-volt supply at relay contact 6T and to the ground at relay contact 6B.

(7) Relay K10 completes a circuit from the tip and the sleeve of the TMS IN jack to winding 6–3 of relay K2. This circuit can be traced from the tip contact of the TMS IN jack, through contacts 1T and 2T of relay K11, through contacts 1T and 2T of relay K10, through winding 6–3 of relay K2, through contacts 2B and 1B of relay K10, through contacts 2B and 1B of relay K11, to the sleeve contact of the TMS IN jack.

(8) Operation of relay K9 rearranges the circuit for the current in winding 7–2 of relay K2 (*a*(1) above). The circuit for the current in winding 7–2 of relay K2 can now be traced from the +130-volt supply, through resistors R5A, R6A, and R19A, through contacts 1T and 2T of relay K9, through winding 7–2 of relay K2, through contacts 2B and 1B of relay K9, to ground. *The current in winding 7–2 of relay K2 is now 10 ma.*

(9) Because there is no current in winding 6–3 of relay K2 and there is 10 ma of current present in winding 7–2, the armature of relay K2 is operated to contact 5.

c. When the plug on the other end of the patch cord is inserted into the test jack for the teletypewriter circuit that is to be tested, winding 6–3 of relay K2 is placed in series with the teletypewriter circuit.

(1) Because 20 ma neutral operation is assumed for the teletypewriter circuit, 20 ma of current will be in winding 6–3 when the teletypewriter circuit is idle or transmitting mark signals and the armature of relay K2 will be operated to contact 4.

(2) When the teletypewriter circuit is transmitting space signals, no current will be in winding 6–3 of relay K2 and the 10 ma of current present in winding 7–2 will cause the armature to operate to contact 5.

71. Receiving Relay Circuit Arranged for Polar Operation
(fig. 24)

The POL switch must be operated when the receiving relay circuit of the teletypewriter test set is arranged for polar operation.

a. When the teletypewriter test set is idle (no teletypewriter circuit patched to the TMS IN jack), approximately 30 ma of current are present in winding 7–2 of relay K2 and approximately 60 ma of current are present in winding 6–3. The polarity of the voltages applied to these windings is such that the current in winding 7–2 creates a magnetic field, which tends to operate the armature of relay K2 to contact 5 (space contact). The current in winding 6–3 creates a magnetic field, which tends to operate the armature of relay K2 to contact 4 (mark contact). The magnetic field created by the 60 ma of current in winding 6–3 is stronger than the magnetic field created by the 30 ma of current in winding 7–2; therefore, the armature of relay K2 is operated to contact 4.

(1) The circuit for the current in winding 7–2 of relay K2 can be traced from the +130-volt supply, through contacts 2B and 1B of relay K8, through contacts 3T and 2T of relay K9, through winding 7–2 of relay K2, through contacts 2B and 3B of relay K9, through contacts 1T and 2T of relay K8, through resistors R13 and R12 to the —130-volt supply.

(2) The circuit for the current in winding 6–3 of relay K2 can be traced from the —24-volt supply, through resistor R18, through contacts 5T and 6T of relay K10, through winding 6–3 of relay K2, through contacts 6B and 5B of relay K10, to ground.

b. When the plug of a patch cord is inserted into the TMS IN jack, a circuit is completed from a grounded contact on the TMS IN jack, through the winding of relay K11, to the —24-volt supply, and relay K11 operates.

(1) Relay K11 completes a circuit from the —24-volt supply, through contacts 9B and 8B, through the winding of

relay K10, to ground, and relay K10 operates.

(2) Relay K11 completes a circuit from the —24-volt supply at the closed contacts of the POL switch, through contacts 6T and 7T of relay K11, through the winding of relay K8, to ground, and relay K8 operates.

(3) Relay K11 removes the shunts from the tip and the sleeve of the TMS IN jack when relay contacts 1T and 3T and relay contacts 1B and 3B open.

(4) Relay K11 completes a circuit from the tip and the sleeve of the TMS IN jack to contacts 1T and 3B and contacts 1B and 3T, respectively, of relay K10.

(5) Relay K10 removes the shunts from the tip and the sleeve of the TMS IN jack when relay contacts 1T and 3T and relay contacts 1B and 3B open.

(6) Relay K10 opens the circuit from winding 6–3 of relay K2 to the —24-volt supply at relay contact 6T and to the ground at relay contact 6B.

(7) Relay K10 completes a circuit from the tip and the sleeve of the TMS IN jack to winding 6–3 of relay K2. This circuit can be traced from the tip contact of the TMS IN jack, through contacts 1T and 2T of relay K11, through contacts 1T and 2T of relay K10, through winding 6–3 of relay K2, through contacts 2B and 1B of relay K10, through contacts 2B and 1B of relay K11, to the sleeve contact of the TMS IN jack.

(8) Operation of relay K8 rearranges the circuit for the 7–2 winding of relay K2 (a(1) above). The circuit for the 7–2 winding is now open because operation of contact 1B on relay K9 disconnects the +130-volt supply and operation of contact 1T on relay K9 disconnects the —130-volt supply. *Under these conditions, no current is present in winding 7–2 of relay K2.*

(9) Because there is no current present in winding 6–3 or winding 7–2 of relay K2, the armature of relay K2, theoretically, will not be operated to either contact (5 or 4) but will remain in the center between the contacts. In practice, however, the armature of a polar relay will usually remain operated to its last effective position. The armature of relay K2, therefore, will remain operated to contact 4 (a above).

c. When the plug on the other end of the patch cord is inserted into the test jack for the teletypewriter circuit that is to be tested, winding 6–3 of relay K2 is placed in series with the teletypewriter circuit. Because polar operation is assumed for the teletypewriter circuit and polar operation is normally used with 30 ma of current, 30 ma of current will be present in winding 6–3 of relay K2 whenever the teletypewriter circuit is idle, transmitting mark signals, or transmitting space signals.

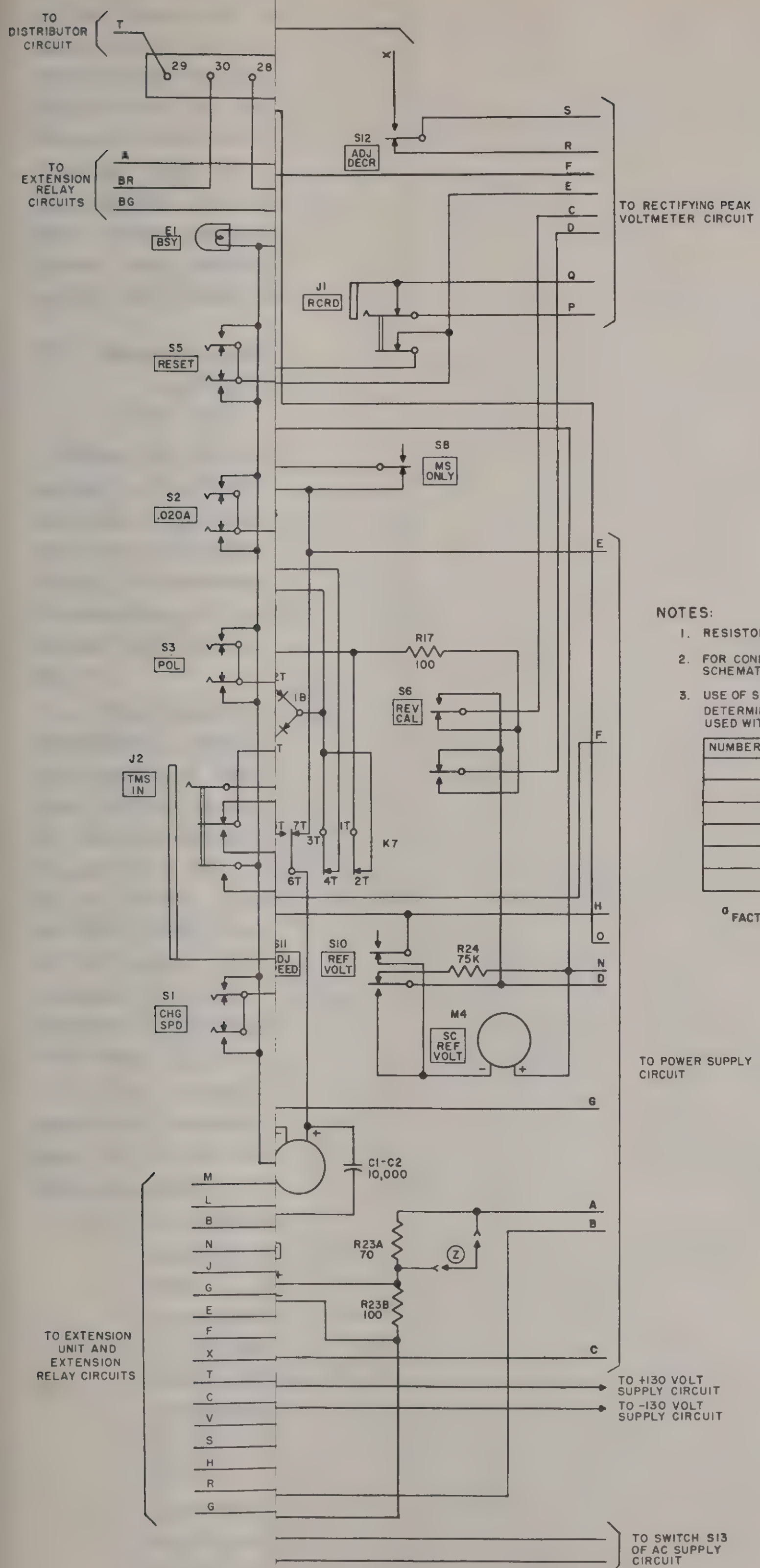
(1) When the teletypewriter circuit is idle or transmitting mark signals, the polarity of the voltage applied to the 6–3 winding of relay K2 will be such that the magnetic field created by the 30 ma of current will cause the armature of relay K2 to operate to contact 4.

(2) When the teletypewriter circuit is transmitting space signals, the polarity of the voltage applied to the 6–3 winding of relay K2 will be such that the magnetic field created by the 30 ma of current will cause the armature of relay K2 to operate to contact 5.

Section IV. MEASURING CIRCUIT

72. General

To simplify explanation, the measuring circuit in the teletypewriter test set is divided into three parts: the comparison circuit, the bias meter circuit, and the total distortion meter circuit (figs. 23 and 26). Switching circuits in the receiving relay circuit (pars. 69–71) and in the distributor circuit (pars. 75–79) control the operation of the measuring circuit when a teletypewriter signal is applied to the teletypewriter test set at the TMS IN jack. Paragraphs 73 and 74 explain the operation of these switching circuits and their effect on the measuring circuit when the teletypewriter test set is arranged for neutral operation. *If the teletypewriter test set is arranged for polar*



NOTES:

1. RESISTORS ARE IN OHMS, CAPACITORS ARE IN UF.
2. FOR CONNECTIONS TO OTHER CIRCUITS, SEE OVERALL SCHEMATIC AND INTERCONNECTION DIAGRAMS.
3. USE OF STRAPPING OPTIONS W, X, Y, AND Z IS DETERMINED BY THE NUMBER OF EXTENSION UNITS USED WITH THE TEST SET. SEE THE CHART BELOW.

NUMBER OF EXTENSION UNITS USED	STRAPPING OPTIONS REQUIRED
NONE	W[a]
1 OR 2	NONE
3	X
4 OR 5	X AND Y
6, 7, OR 8	Y AND Z
9 OR MORE	X, Y, AND Z

[a] FACTORY INSTALLED ON NEW EQUIPMENT

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relay K10, to ground, and relay K10 operates.

(2) Relay K11 completes a circuit from the —24-volt supply at the closed contacts of the POL switch, through contacts 6T and 7T of relay K11, through the winding of relay K8, to ground, and relay K8 operates.

(3) Relay K11 removes the shunts from the tip and the sleeve of the TMS IN jack when relay contacts 1T and 3T and relay contacts 1B and 3B open.

(4) Relay K11 completes a circuit from the tip and the sleeve of the TMS IN jack to contacts 1T and 3B and contacts 1B and 3T, respectively, of relay K10.

(5) Relay K10 removes the shunts from the tip and the sleeve of the TMS IN jack when relay contacts 1T and 3T and relay contacts 1B and 3B open.

(6) Relay K10 opens the circuit from winding 6–3 of relay K2 to the —24-volt supply at relay contact 6T and to the ground at relay contact 6B.

(7) Relay K10 completes a circuit from the tip and the sleeve of the TMS IN jack to winding 6–3 of relay K2. This circuit can be traced from the tip contact of the TMS IN jack, through contacts 1T and 2T of relay K11, through contacts 1T and 2T of relay K10, through winding 6–3 of relay K2, through contacts 2B and 1B of relay K10, through contacts 2B and 1B of relay K11, to the sleeve contact of the TMS IN jack.

(8) Operation of relay K8 rearranges the circuit for the 7–2 winding of relay K2 (*a*(1) above). The circuit for the 7–2 winding is now open because operation of contact 1B on relay K9 connects the +130-volt supply and operation of contact 1T on relay K9 disconnects the —130-volt supply. *Under these conditions, no current is present in winding 7–2 of relay K2.*

(9) Because there is no current present in winding 6–3 or winding 7–2 of relay K2, the armature of relay K2, theoretically, will not be operated to either contact (5 or 4) but will remain in the center between the contacts. In practice, however, the armature of a polar relay will usually remain operated to its last effective position. The armature of relay K2, therefore, will remain operated to contact 4 (*a* above).

c. When the plug on the other end of the patch cord is inserted into the test jack for the teletypewriter circuit that is to be tested, winding 6–3 of relay K2 is placed in series with the teletypewriter circuit. Because polar operation is assumed for the teletypewriter circuit and polar operation is normally used with 30 ma of current, 30 ma of current will be present in winding 6–3 of relay K2 whenever the teletypewriter circuit is idle, transmitting mark signals, or transmitting space signals.

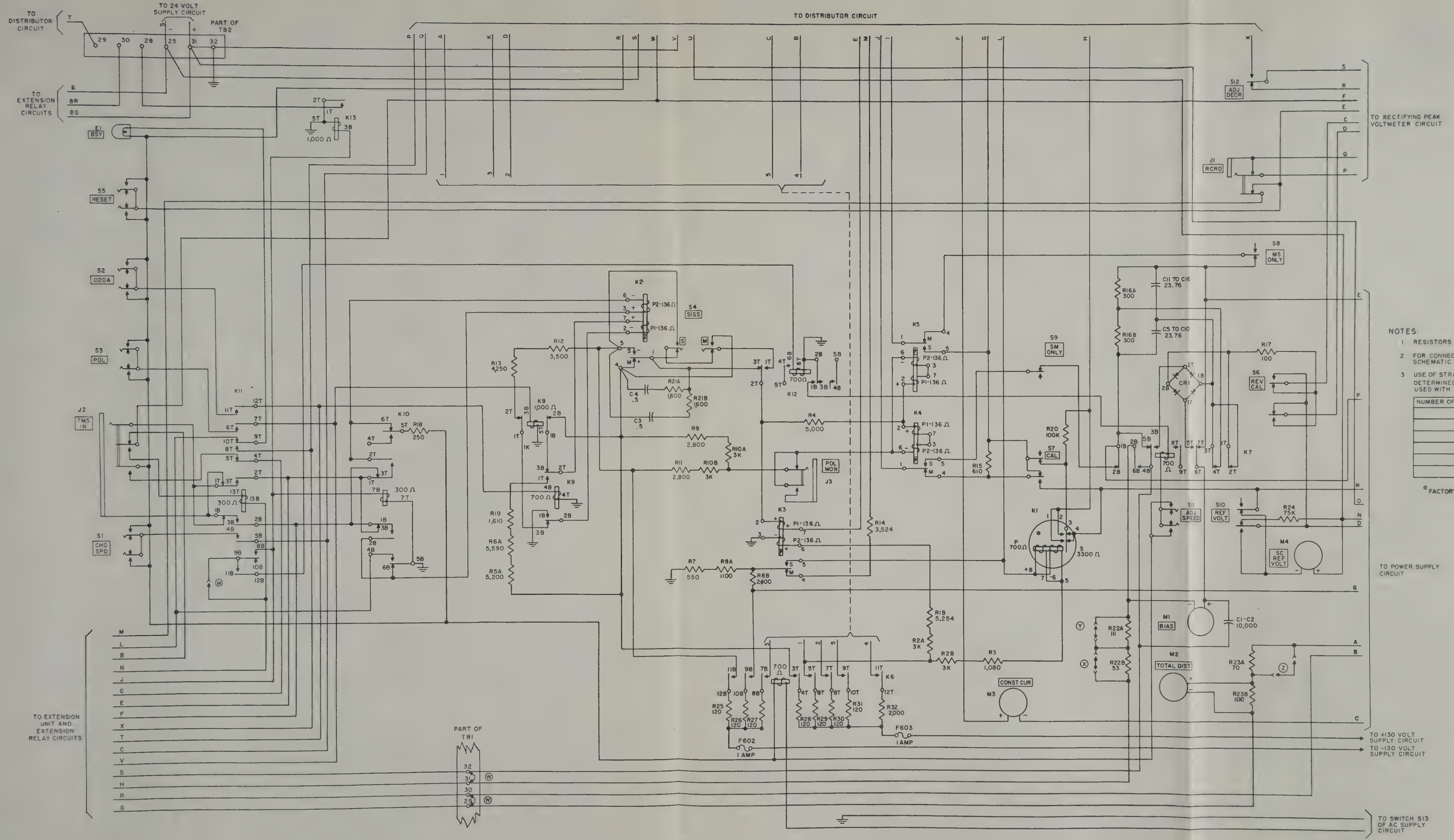
(1) When the teletypewriter circuit is idle or transmitting mark signals, the polarity of the voltage applied to the 6–3 winding of relay K2 will be such that the magnetic field created by the 30 ma of current will cause the armature of relay K2 to operate to contact 4.

(2) When the teletypewriter circuit is transmitting space signals, the polarity of the voltage applied to the 6–3 winding of relay K2 will be such that the magnetic field created by the 30 ma of current will cause the armature of relay K2 to operate to contact 5.

Section IV. MEASURING CIRCUIT

72. General

To simplify explanation, the measuring circuit in the teletypewriter test set is divided into three parts: the comparison circuit, the bias meter circuit, and the total distortion meter circuit (figs. 23 and 26). Switching circuits in the receiving relay circuit (pars. 69–71) and in the distributor circuit (pars. 75–79) control the operation of the measuring circuit when a teletypewriter signal is applied to the teletypewriter test set at the TMS IN jack. Paragraphs 73 and 74 explain the operation of these switching circuits and their effect on the measuring circuit when the teletypewriter test set is arranged for neutral operation. *If the teletypewriter test set is arranged for polar*



NOTES:

1 RESISTORS ARE IN OHMS, CAPACITORS ARE IN UF.

2 FOR CONNECTIONS TO OTHER CIRCUITS, SEE OVERALL SCHEMATIC AND INTERCONNECTION DIAGRAMS.

3 USE OF STRAPPING OPTIONS W, X, Y, AND Z IS DETERMINED BY THE NUMBER OF EXTENSION UNITS USED WITH THE TEST SET. SEE THE CHART BELOW.

NUMBER OF EXTENSION UNITS USED	STRAPPING OPTIONS REQUIRED
NONE	W[a]
1 OR 2	NONE
3	X
4 OR 5	X AND Y
6 7, OR 8	Y AND Z
9 OR MORE	X, Y, AND Z

[a] FACTORY INSTALLED ON NEW EQUIPMENT

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Figure 25. Input circuit and measuring circuit, schematic diagram.

operation, the explanations for the operation of the measuring circuit are still the same because relay K2 in the receiving relay circuit converts all signals to polar signals before applying them to the distributor and measuring circuits (pars. 67–71). A simplified schematic diagram (fig. 26) is used to supplement the explanation of the measuring circuits; however, these circuits (with more detail) also appear on a partial schematic digram (fig. 25) and on the overall schematic diagram (fig. 73).

73. Measuring Circuit, Mark Signal Applied to TMS IN Jack
(fig. 26)

When an idle teletypewriter circuit is connected to the TMS IN jack at a teletypewriter test set or at one of its extension units, the armature of relay K2 in the receiving relay circuit is operated to contact 4 (pars. 69–71). Explanation of how this condition affects the measuring circuit, is shown in *a* through *d* below.

a. The polarity of the voltage applied to the windings of relays K4 and K5, in the comparison circuit, is such that the armature of each relay will be operated to contact 4. The circuit for the windings of relays K4 and K5 can be traced from the —130-volt supply of resistors R9 and R10A, through the normal contacts of the POL MON jack, through windings 6–3 and 7–2 of relay K4 (which are in parallel with windings 6–3 and 7–2 of relay K5), through resistor R4, through the armature and contact 4 of relay K2, to a +130-volt supply.

b. The polarity of the voltage and the amount of current present in the windings of relay K3, in the character timer circuit, is such that its armature will be operated to contact 4.

(1) The circuit for the current in the 6–3 winding of relay K3 can be traced from a +130-volt supply, through resistors R2A and R1B, through winding 6–3 of relay K3, to ground. The current in this circuit (approx. 15 ma), creates a magnetic field, which tends to operate the armature of relay K3 to contact 5.

(2) The circuit for the current in the 7–2 winding of relay K3 can be traced from ground at pin 8 of tube V202, through tube V202 to pin 3 (the tube is conducting), through winding 7–2 of relay K3, through the armature and contact 4 of relay K2, to a +130-volt supply. The current in this circuit (approx. 30 ma), creates a magnetic field, which operates the armature of relay K3 to contact 4.

(3) The conditions for the conduction in tube V202 can be explained as follows: The plates of tube V201 (pins 3 and 5) are at a positive potential because they are connected to a +130-volt supply through the CHAR potentiometer, resistors R216 and R217, and the CODE switch. The cathodes of tube V201 (pins 4 and 8) are grounded so that the tube conducts; however, because of the large resistance in its plate circuit (approx. 385,000 ohms), the actual voltage at its plates is approximately zero (ground potential). The plates of tube V201 are connected to the control grid of tube V202 (pin 5) and therefore the control grid of tube V202 is also approximately zero (ground potential). The screen grid of tube V202 (pin 4) is at a potential of about 100 volts because of the voltage-divider action of resistors R230 and R231.

c. The circuit for the winding of relay K1, in the character timer circuits is open at contact 5 of relay K3 so that the armature of relay K1 will remain in the unoperated position.

d. Measuring capacitors C208 and C209, in the comparison circuit, are connected to the stop-compensating voltage (SC VOLTS) and also to the constant-current supply (CONST CUR).

(1) One circuit can be traced from capacitors C208 and C209, through the armature and contact 4 of relay K4, through contacts 3 and 4 of relay K1, to resistor R113 of the stop-compensating voltage source in the power supply circuit.

(2) The other circuit can be traced from capacitors C208 and C209, through the armature and contact 4 of relay K4, through resistor R208, to resistor R114 of the constant-current source in the power supply circuit.

74. Measuring Circuit, Space Signal Applied to TMS IN Jack

(fig. 26)

When a start signal (space) is received at the TMS IN jack of the teletypewriter test set, from a teletypewriter circuit that is under test, the armature of relay K2 is operated to contact 5 (pars. 67–71). Explanation of how this condition affects the measuring circuit is shown in *a* through *e* below.

a. When the armature of relay K2 is operated to contact 5, a —130-volt potential is applied to the plate of tube V202 (pin 3), through the 7–2 winding of relay K2, and the tube stops conducting. When tube V202 stops conducting, there is no current in winding 7–2 of relay K3; therefore, the armature of relay K3 is operated to contact 5 because of the current still in winding 6–3 (par. 73*b*(1)). When the armature of relay K3 is operated to contact 5, two things happen:

(1) The negative potential at the voltage-divider circuit (resistors R7, R7A, R8B, and R26) is removed from the grids of tube V203 when the armature of relay K3 moves from contact 4. Removal of the negative potential from the control grid of tube V203B (pin 5) causes the pulse oscillator circuit to function (par. 77).

(2) A circuit is completed for the operation of relay K1 when the armature of relay K3 moves to contact 5. This circuit can be traced from ground at resistor R8A, through resistors R8A and R7, through the armature and contact 5 of relay K3, through the 6–5 winding of relay K1, through resistors R2 and R3, to a +130-volt supply.

b. When relay K1 operates, the circuit between the stop-compensating voltage supply (resistor R113) and the measuring capacitors (C208 and C209) is opened at contacts 3 and 4 of relay K1. At the same time, resistor R20 is shunted by contacts 2 and 3 of relay K1. This shunt provides a direct circuit between the cathode of tube V204 (pin 4) and contacts 4 and 5 of relays K4 and K5, respectively.

c. The polarity of the voltage applied to the windings of relays K4 and K5, in the comparison circuit, is such that the armature of each relay will be operated to contact 5. The circuit for the windings of relays K4 and K5 can be traced from the +130-volt supply at resistor R11, through resistors R11 and R10B, through the normal contacts of the POL MON jack, through windings 6–3 and 7–2 of relay K4 (which are in parallel with windings 6–3 and 7–2 of relay K5), through resistor R4, through the armature and contact 5 of relay K2, to a —130-volt supply.

d. When the armature of relay K4 is operated to contact 5, a circuit is completed from measuring capacitors C208 and C209, through the BIAS and TOTAL DIST meters, to the reference voltage source (resistor R112). Because capacitors C208 and C209 were previously connected to the stop-compensating voltage (par. 73*d*(1)), which is at the same potential as the reference voltage, there will be no indication on either the BIAS or the TOTAL DIST meter.

e. When the armature of relay K5 is operated to contact 5, a circuit is completed from measuring capacitors C210 and C211, through resistor R208, to the constant-current source (R113). At this time, capacitors C210 and C211 start to charge from the constant-current source.

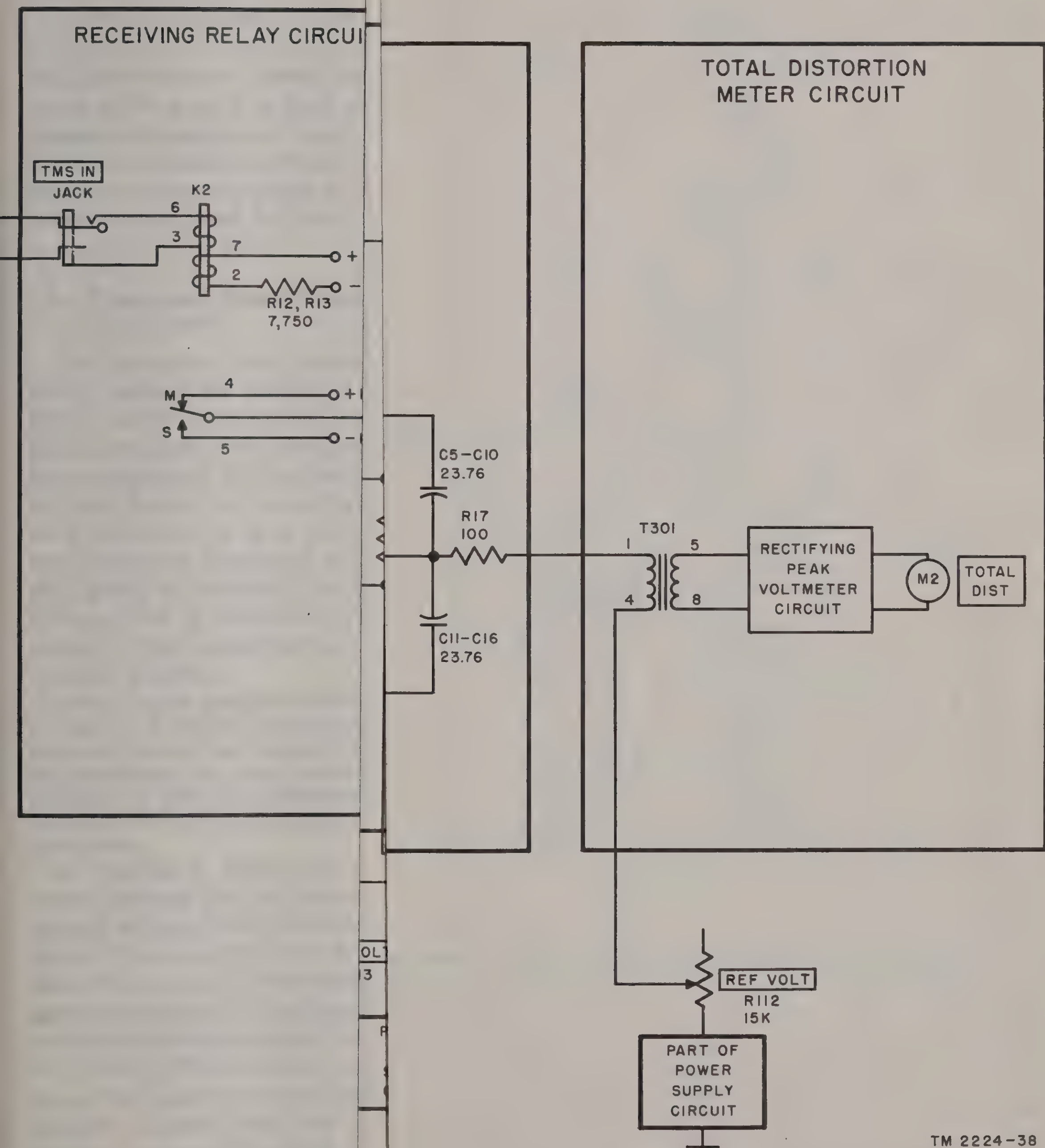
Note. When the teletypewriter test set is arranged for operation at speeds of 75 or 100 wpm, measuring capacitors C208 through C211 are replaced by other capacitors (par. 80).

Section V. DISTRIBUTOR CIRCUIT

75. General

a. The distributor circuit grounds the capacitors in the comparison circuit at the correct instant with respect to the first transition of the start pulse of a teletypewriter character so that capacitors in the measuring circuit can be charged from a constant-current source for a fixed length of time. The distributor circuit also provides the timing for the switching operations that are necessary for comparing the voltage developed across these capacitors with a reference voltage, so that any deviation in the length of a signal element will be indicated on the BIAS and TOTAL DIST meters.

b. To simplify explanation, the distributor circuit can be divided into four parts: the char-


RECEIVING RELAY CIRCUI
TMS IN
JACK
K2
6
3
7
2
+
-
R12, R13
7,750
M
S
4
5
C5-C10
23.76
R17
100
C11-C16
23.76
TOTAL DISTORTION
METER CIRCUIT
T301
1
4
5
8
RECTIFYING
PEAK
VOLTMETER
CIRCUIT
M2
TOTAL
DIST
REF VOLT
R112
15K
PART OF
POWER
SUPPLY
CIRCUIT
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74. Measuring Circuit, Space Signal Applied to TMS IN Jack

(fig. 26)

When a start signal (space) is received at the TMS IN jack of the teletypewriter test set, from a teletypewriter circuit that is under test, the armature of relay K2 is operated to contact 5 (pars. 67–71). Explanation of how this condition affects the measuring circuit is shown in *a* through *e* below.

a. When the armature of relay K2 is operated to contact 5, a —130-volt potential is applied to the plate of tube V202 (pin 3), through the 7–2 winding of relay K2, and the tube stops conducting. When tube V202 stops conducting, there is no current in winding 7–2 of relay K3; therefore, the armature of relay K3 is operated to contact 5 because of the current still in winding 6–3 (par. 73*b*(1)). When the armature of relay K3 is operated to contact 5, two things happen:

(1) The negative potential at the voltage-divider circuit (resistors R7, R7A, R8B, and R26) is removed from the grids of tube V203 when the armature of relay K3 moves from contact 4. Removal of the negative potential from the control grid of tube V203B (pin 5) causes the pulse oscillator circuit to function (par. 77).

(2) A circuit is completed for the operation of relay K1 when the armature of relay K3 moves to contact 5. This circuit can be traced from ground at resistor R8A, through resistors R8A and R7, through the armature and contact 5 of relay K3, through the 6–5 winding of relay K1, through resistors R2 and R3, to a +130-volt supply.

b. When relay K1 operates, the circuit between the stop-compensating voltage supply (resistor R113) and the measuring capacitors (C208 and C209) is opened at contacts 3 and 4 of relay K1. At the same time, resistor R20 is shunted by contacts 2 and 3 of relay K1. This shunt provides a direct circuit between the cathode of tube V204 (pin 4) and contacts 4 and 5 of relays K4 and K5, respectively.

c. The polarity of the voltage applied to the windings of relays K4 and K5, in the comparison circuit, is such that the armature of each relay will be operated to contact 5. The circuit for the windings of relays K4 and K5 can be traced from the +130-volt supply at resistor R11, through resistors R11 and R10B, through the normal contacts of the POL MON jack, through windings 6–3 and 7–2 of relay K4 (which are in parallel with windings 6–3 and 7–2 of relay K5), through resistor R4, through the armature and contact 5 of relay K2, to a —130-volt supply.

d. When the armature of relay K4 is operated to contact 5, a circuit is completed from measuring capacitors C208 and C209, through the BIAS and TOTAL DIST meters, to the reference voltage source (resistor R112). Because capacitors C208 and C209 were previously connected to the stop-compensating voltage (par. 73*d*(1)), which is at the same potential as the reference voltage, there will be no indication on either the BIAS or the TOTAL DIST meter.

e. When the armature of relay K5 is operated to contact 5, a circuit is completed from measuring capacitors C210 and C211, through resistor R208, to the constant-current source (R113). At this time, capacitors C210 and C211 start to charge from the constant-current source.

Note. When the teletypewriter test set is arranged for operation at speeds of 75 or 100 wpm, measuring capacitors C208 through C211 are replaced by other capacitors (par. 80).

Section V. DISTRIBUTOR CIRCUIT

75. General

a. The distributor circuit grounds the capacitors in the comparison circuit at the correct instant with respect to the first transition of the start pulse of a teletypewriter character so that capacitors in the measuring circuit can be charged from a constant-current source for a fixed length of time. The distributor circuit also provides the timing for the switching operations that are necessary for comparing the voltage developed across these capacitors with a reference voltage, so that any deviation in the length of a signal element will be indicated on the BIAS and TOTAL DIST meters.

b. To simplify explanation, the distributor circuit can be divided into four parts: the char-

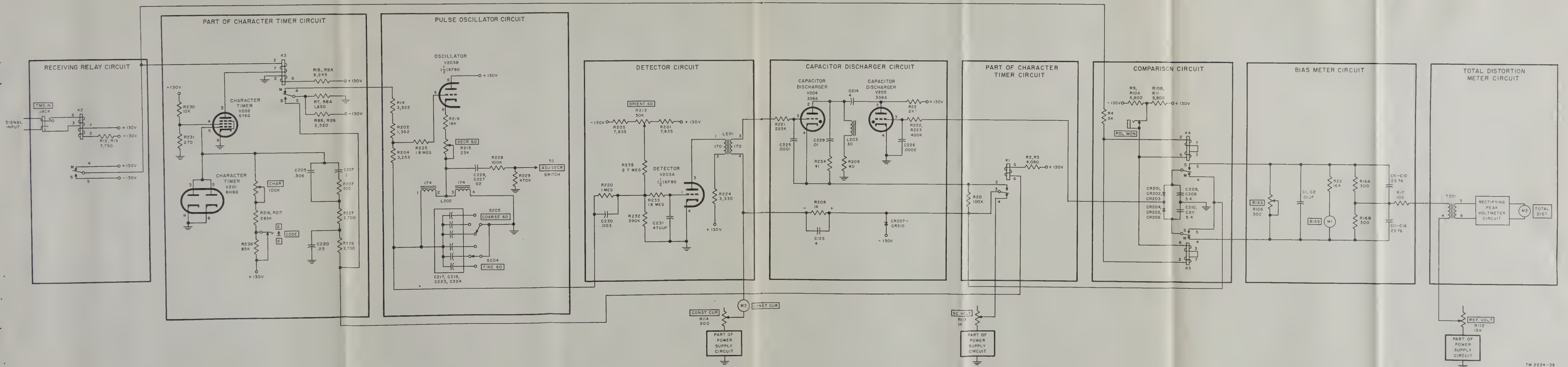

Figure 26. Input, distributor, and measuring circuits, simplified schematic diagram.

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acter timer circuit, the pulse oscillator circuit, the detector circuit, and the capacitor discharger circuit (figs. 23 and 26). These circuits are explained in paragraphs 76 through 79 below. A simplified diagram (fig. 26) is used to supplenment the explanation of the distributor circuits; however, these circuits (with more detail) also appear on a partial schematic diagram (fig. 28) and on the overall schematic diagram (fig. 73).

c. The explanations in paragraphs 76 through 79 are based on the assumption that the teletypewriter circuit under test is operating at 60 wpm and that each teletypewriter character consists of a 5-unit code. The explanations are similar for other types of operation; however, different values of resistance and capacitance are used for some of the circuit elements (pars. 80–83).

76. Character Timer Circuit (fig. 26)

The character timer circuit is used to accurately control the length of time required by the distributor circuit to complete its operations for each teletypewriter character. This is accomplished by controlling the operation of relay K3 so that when its armature is operated to contact 5 by a *start* pulse, it will not be allowed to reoperate to contact 4 until a *stop* pulse is received. The operation of relay K3 must not be affected by any of the selecting pulses. This control action is explained in *a* through *g* below.

Note. In this paragraph, reference to the bottom of a capacitor is defined as reference to the plate of the capacitor symbol that is closest to the bottom edge of the illustration (fig. 26). Reference to the top of a capacitor is defined as reference to the plate of the capacitor symbol that is closest to the top edge of the illustration.

a. During a stop pulse or when teletypewriter signals are not being received, the armature of relay K3 is operated to contact 4 because of the electron flow from the cathode of tube V202 (pin 8), through tube V202 to pin 3, through winding 7–2 of relay K3, through the armature and contact 4 of relay K2, to a +130-volt supply. This electron flow is possible because the plate of tube V202 (pin 3) is at a positive potential and the grid of tube V202 (pin 5) is almost at ground potential. This grid is almost at ground potential because the positive potential connected to the plates of tube V201 (pins 3 and 5), through the CHAR potentiometer, resistors R216 and R217 and the CODE switch, causes tube V201 to conduct. The resulting current that flows through these resistors drops the voltage so that at the plates of tube V201, the potential is almost zero (ground potential). Because the tops of capacitors C205 and C207 are connected to the plates of tube V201, they too are almost at ground potential. The bottoms of capacitors C205 and C207 are connected to a +130-volt supply at resistors R2 and R3.

b. When a start pulse is received, the armature of relay K2 is operated to contact 5 and a negative potential is connected to the plate of tube V202. Tube V202 stops conducting and the current flow through winding 7–2 of relay K3 ceases. The armature of relay K3 operates to contact 5 under the influence of the current still in its 6–3 winding. A negative potential of about 50 volts (note voltage-divider action of resistors R7, R8, and R26) is connected to terminal 6 of relay K1; therefore, relay K1 operates. The —50-volt potential is also connected to the bottom of capacitors C205 and C207. The voltage on the bottom of capacitors C205 and C207 changes from +130 to —50 volts (a drop of 180 volts). This voltage change, in turn, is transferred to the top of capacitors C205 and C207. The voltage on the top of capacitors C205 and C207 was previously almost at ground potential; therefore, it now drops 180 volts to approximately —180 volts. This action is explained as follows:

(1) When the +130-volt potential is connected to the bottom of capacitors C205 and C207, there is a deficiency of electrons on these plates (equal to 130 volts). The top of these capacitors is approximately at ground potential and the capacitors are in a stable condition; the negative charge (electrons) equals the positive charge.

(2) When the —50-volt supply is connected to the bottom of capacitors C205 and C207, an electron stream rushes in and establishes an excess of electrons (equal to a potential of —50 volts); however, the electrons that rushed in are equal to a total of 180 volts (130 volts to overcome the 130-volt deficiency of electrons and 50 volts for the connected negative supply).

(3) This electron flow is practically instantaneous because the resistance in the path of this circuit is very small (about 7,000 ohms). The 180-volt electron potential on the bottom of capacitors C205 and C207 keeps positive charges on the top of the capacitors, thus freeing electrons equivalent to a potential of 180 volts. This establishes a potential (at that instant) of about —180 volts on the top of capacitors C205 and C207.

c. When a negative potential is established on top of capacitors C205 and C207, the plates of tube V201 and the grid of tube V202 become negative. When the plates of tube V201 become negative, tube V201 stops conducting and therefore acts as an open circuit. When the grid of tube V202 becomes negative, the tube will not conduct, regardless of the potential connected to its plate by the armature of relay K2, until the potential on the grid is driven above the cutoff bias. The armature of relay K3 cannot operate to contact 4; thus, the armature of relay K1 cannot release until tube V202 again conducts and completes a circuit for current in winding 7–2 of relay K3. The time that a negative potential is applied to the grid of tube V202 to prevent conduction is made equal to the length of time required for the complete transmission of one teletypewriter character (from start pulse to stop pulse) by the action of an RC (resistance-capacitance) time-delay circuit.

d. Because tubes V201 and V202 are not conducting, electron flow can take place only from the top of capacitors C205 and C207 (which are at a potential of —180 volts), through the circuit provided by the CHAR potentiometers, resistors R216 and R217, and the CODE switch to the +130-volt supply. Capacitors C205 and C207, therefore, discharge through this circuit; however, the discharge does not occur instantaneously because of the large resistance offered by the CHAR potentiometer (set for approximately 50,000 ohms) and resistors R216 and R217 (285,000 ohms). The charge or discharge time of an RC time-delay circuit is a function of the values of resistance and capacitance in the circuit. In this case, the resistance is adjusted so that the discharge time required for capacitors C205 and C207 is equal to the time required for the transmission of one complete teletypewriter character that consists of a 5-unit code. If the teletypewriter character consists of a 6-unit code, the CODE switch is operated to position 6. This operation removes the shunt across resistor R236 in the RC time-delay circuit and increases the resistance in the discharge path of capacitors C205 and C207 by 85,000 ohms. This increased resistance will increase the time required for capacitors C205 and C207 to discharge. In this case, the discharge time required for capacitors C205 and C207 is equal to the time required for the transmission of one complete teletypewriter character that consists of a 6-unit code.

e. When capacitors C205 and C207 discharge and the potential on the top of capacitors C205 and C207 becomes slightly positive, tube V201 starts to conduct and again maintains the grid voltage of tube V202 at about ground potential. The CHAR potentiometer is adjusted during the initial adjustments of the teletypewriter test set so that the grid of tube V202 reaches a bias potential that will permit sufficient current to flow through tube V202 to operate the armature of relay K3 to contact 4 when the armature of relay K2 operates to contact 4 for the stop pulse. The current that passes through tube V202 will remain about 30 ma until the next start pulse is received. When the armature of relay K3 is operated to contact 4, the armature of relay K1 releases and the bottom of capacitors C205 and C207 are again connected to a +130-volt supply at resistors R2 and R3. The character timer circuit is now ready for another cycle of operation when the next start pulse is received.

f. The circuit for capacitors C205 and C207 is arranged for use with different values of capacitance when the teletypewriter test set is arranged for operation at speeds of 75 or 100 wpm (par. 80). As the speed of operation is increased, the time-delay interval in the character timer circuit must be reduced. This is accomplished by using smaller values of capacitance in the RC time-delay circuit. The RC time-delay circuit is designed so that once the CHAR potentiometer is set correctly for one operating speed it does not require additional resistance adjustment each time the capacitance values are changed to provide proper timing for other operating speeds.

g. Resistor R207 allows capacitors C205 and C207 to charge at approximately the same rate.

Resistors R226 and R227 and capacitor C220 serve as a filter to impede the charging current applied to capacitors C205 and C207. This prevents the establishment of an oscillatory circuit by the inductive winding of relay K1 and capacitors C205 and C207. Oscillation must be prevented; it might cause the armature of relay K1 to vibrate or cause capacitors C205 and C207 to discharge prematurely.

77. Pulse Oscillator Circuit
(fig. 26)

The pulse oscillator circuit provides electrical pulses that are used to form the basis for timing the capacitor grounding intervals in the capacitor discharger circuit (par. 79). Operation of the pulse oscillator circuit is controlled by relay K3 in the character timer circuit (par. 76). For this reason, the pulses generated by the pulse oscillator circuit start and stop with the start and stop pulses, respectively, of each teletypewriter character.

a. During a stop pulse or when teletypewriter signals are not being received, oscillation cannot occur in the pulse oscillator circuit because of the large bias (—50 volts) applied to the grid of tube V203B (pin 5). The circuit for this bias potential can be traced from the grid through resistors R225, R204, and R14, through the armature and contact 4 of relay K3, to a voltage-divider arrangement that consists of resistors R7, R8, and R26 (between the —130-volt supply and ground).

b. When a start pulse is received from the teletypewriter circuit being tested, the armature of relay K3 operates to contact 5 and the negative bias is removed from the grid of tube V203B and the tube starts to conduct. When tube V203B conducts, a circuit is completed from ground at inductor L202, through the 4–3 winding of inductor L202, through the DECR 60 potentiometer and resistor R219, through tube V203B, to a +130-volt supply. As the magnitude of the current passing through winding 4–3 of inductor L202 changes, a voltage is induced in winding 2–1 of inductor L202. This voltage, with the voltage in winding 4–3 of inductor L202, is applied to the grid of tube V203B through resistors R204 and R225. The voltage on the grid, in turn, controls the current in the tube.

c. Adjustable capacitors C217, C219, C223, and C224, in parallel with the windings of inductor L202, form a resonant circuit, which, with tube V203B, provides the proper conditions for oscillation at a constant rate. The rate of oscillation is equal to 1 cycle per unit of pulse duration. The amount of resistance in the cathode circuit of tube V203B determines the magnitude of grid bias and, consequently, the amplitude of the oscillations. The pulse oscillator circuit begins to oscillate without a starting transient. The oscillator circuit is a typical Hartley oscillator circuit; therefore, its theory of operation is not discussed.

d. The frequency of operation for 60-wpm teletypewriter signals can be changed by controlling the values of capacitance in parallel with inductor L202 with the COARSE 60 and FINE 60 switches that are provided on the teletypewriter test set. When 75- or 100-wpm teletypewriter signals are being tested, additional switching circuits are provided to permit substitution of other capacitors that will provide control of the oscillating frequency at these operating speeds (par. 80).

e. The amplitude of oscillations for 60-wpm teletypewriter signals can be changed by controlling the values of resistance in the cathode circuit of tube V203B with the DECR 60 potentiometer that is provided on the teletypewriter test set. When 75- or 100-wpm teletypewriter signals are being tested, additional switching circuits are provided to permit substitution of other resistors that will provide control of the amplitude of the oscillations at these operating speeds (par. 80).

f. When a stop pulse is received from the teletypewriter circuit under test, the armature of relay K3 is operated to contact 4. A negative potential is again connected to the grid of tube V203B and oscillation stops. The circuit provided by resistors R14, R202, and R204, with the capacitors in parallel with inductor L202, causes the oscillations to stop quickly.

78. Detector Circuit
(figs. 26 and 27)

The detector circuit rectifies the sine wave voltages that are generated in the pulse oscillator circuit (par. 77) and also provides sharp, spiked voltages that can be used to trigger the capacitor circuit (par. 79).

a. The voltages generated in the pulse oscillator circuit (fig. 26) are applied to the grid of tube V203A (pin 1) through the parallel cir-

cuit formed by resistor R220 and capacitor C230. Resistor R232 is the grid resistor and resistor R233 and capacitor C231 form a signal integrater circuit. The grid of tube V203A is biased by the voltage developed in the voltage-divider circuit, which consists of resistors R201 and R205 and the ORIENT 60 potentiometer. The ORIENT 60 potentiometer is used to adjust the bias voltage. The range of adjustment is from approximately +100 to —100 volts. The output of the detector circuit is coupled to the grid of tube V204 (pin 3) in the capacitor discharger circuit by the transformer action of inductor L201.

b. Figure 27 shows five basic curves (A, B, C, D, and E) that can be used to analyze the operation of the detector circuit. Curve A represents a teletypewriter signal as it appears on the line. Curve B represents the oscillator voltage generated in the pulse oscillator circuit. Curve C represents the integrated oscillator voltage that is applied to the grid of tube V203A. Curve D represents the plate current in tube V203A. Curve E represents the grid voltage that is applied to the grid of tube V204 in the capacitor discharger circuit. Each curve is placed below the other in a manner which permits the analysis of voltage and current wave shapes at any given instant during the transmission of a teletypewriter character.

c. The grid of tube V203A is biased below the cutoff voltage of the tube (curve C) ; therefore, the tube will not conduct until the voltage applied to the grid from the pulse oscillator circuit (curve B) rises above the cutoff voltage (rectification). The integrator circuit (resistor R233 and capacitor C231) distorts the voltage applied to the grid of tube V203A (curve C). The effect of this distorted signal voltage on the grid of tube V203A is best explained with the aid of curve D. The pulses of plate current illustrated in this curve resemble saw teeth and the current flow drops to zero very rapidly as the signal voltage on the grid (curve C) drops below the cutoff voltage. These pulses of plate current are applied to the primary winding of inductor L201 and the resulting induced voltages in the secondary winding (curve E) are applied to the grid of tube V204 in the capacitor discharger circuit. Winding 3–4 of inductor L201 is poled so that the voltage pulses applied to the grid of tube V204 are positive. These positive voltage pulses trigger the capacitor discharger circuit.

d. The ORIENT 60 potentiometer permits control of the bias voltage applied to the grid of tube V203A. An increase in the bias voltage will cause the spiked voltage pulses in curve E to shift to the left and a decrease in the bias voltage will cause the spiked voltage pulses to shift to the right. As a result, the ORIENT 60 potentiometer provides a means of orienting the capacitor grounding intervals properly, with respect to the start pulse (curve A) when the teletypewriter test set is arranged for 60-wpm operation. A separate ORIENT potentiometer functions the same when the teletypewriter test set is arranged for 75- or 100-wpm operation (par. 80).

79. Capacitor Discharger Circuit
(fig. 26)

The capacitor discharger circuit discharges capacitors C208 and C209 or C210 and C211 at the middle of each selecting pulse.

a. The grid of tube V204 (pin 3) is 30 volts more negative than the cathode (pin 4). This bias voltage is developed across resistor R208. Capacitor C215 aids in maintaining this bias. The cathode of tube V204 is at the same negative potential as capacitors C208 and C209 or capacitors C210 and C211, depending on which set of capacitors is connected to the constant-current lead (from CONST CUR meter). This potential varies between ground and —130 volts. The plate of tube V204 is normally at ground potential. The plate circuit can be traced from pin 2 of tube V204, through inductor L203 and resistor R209, to ground. Tube V204 is not conducting because it is biased below firing potential. If the first selective pulse after the start pulse is a mark pulse, the armatures of relays K4 and K5 operate to contact 4 and capacitors C208 and C209 are connected to the constant-current supply. At this time, the potential on capacitors C208 and C209 is —55 volts (same as reference voltage) because the capacitors were previously connected to the reference voltage supply through the bias meter circuit and total distortion meter circuit. Capacitors C208 and C209 now start to charge to a more negative potential from the constant-current supply. When a positive pulse from the detector circuit is applied to the grid of tube V204, it starts to conduct vigorously and

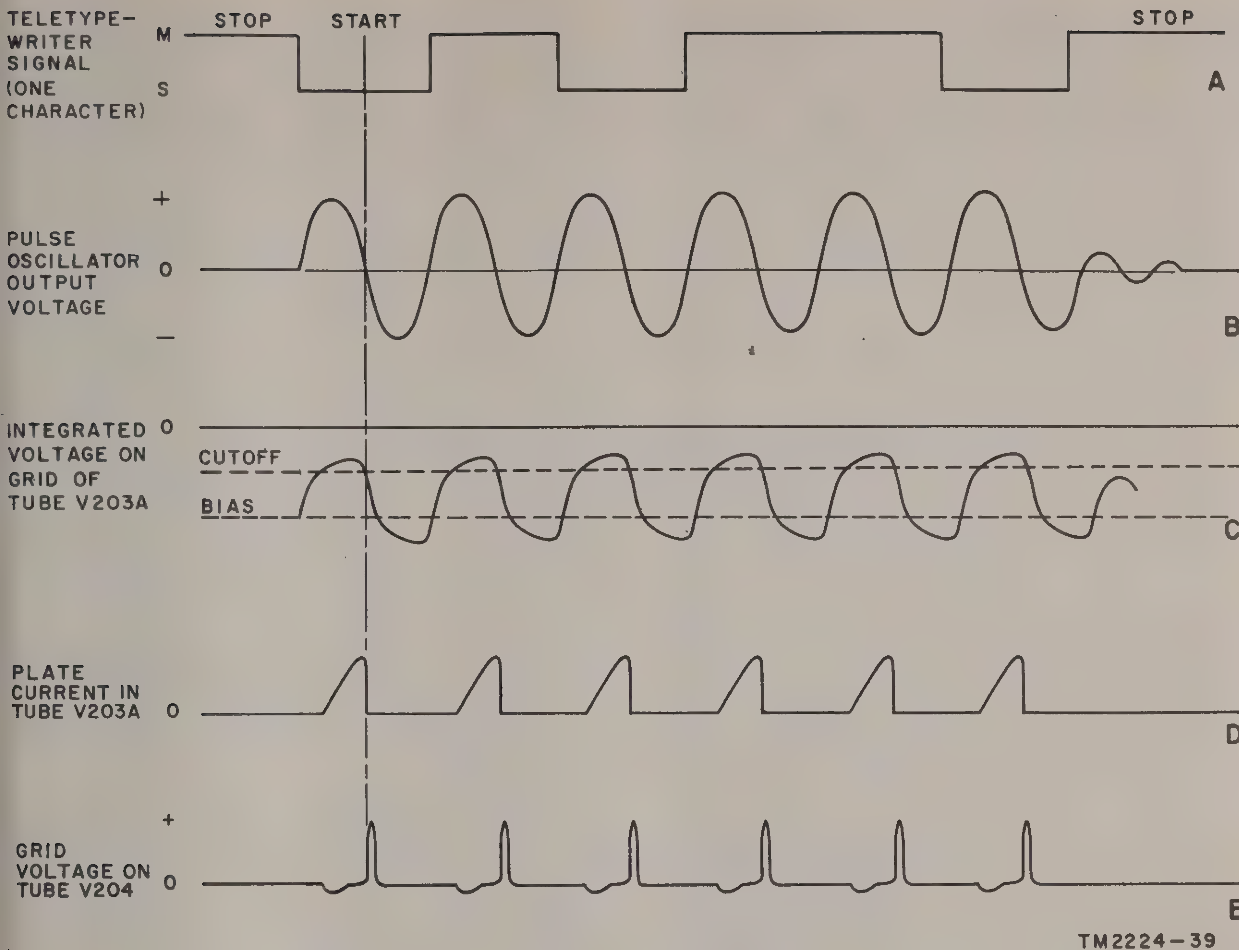


Figure 27. Oscillograms for detector circuit.

capacitors C208 and C209 are grounded. The circuit can be traced from capacitors C208 and C209, through the armature and contact 4 of relay K4, through operated contacts 3 and 2 of relay K1, through tube V204, through inductor L203 and resistor R209, to ground. Tube V204 is a gas-filled thyratron tube. When this tube fires, the gas ionizes and the tube conducts very rapidly. To further assure a quick discharge of capacitors C208 and C209, the value of inductor L203 is selected so that it will form a series-tuned circuit with capacitors C208 and C209. As a result of the circuitry and the tube used, the potential on capacitors C208 and C209 drops *rapidly* to zero when a positive potential is applied to the grid of tube V204. Capacitors C210 and C211 are discharged similarly when space pulses are received.

b. Conduction in tube V204 stops the instant the potential on capacitors C208 and C209 reaches zero. Varistors CR201, CR202, and CR203 are connected between capacitors C208 and C209 and the grid of tube V205 (pin 3). The varistors are poled so that the potential on capacitors C208 and C209 is extended to the grid of tube V205; therefore, when the charge on capacitors C208 and C209 reaches ground potential, the grid of tube V205 is also at ground potential and thyratron tube V205 is triggered and starts to conduct vigorously. The potential on the plate of tube V205 is +130 volts when the tube is not conducting; however, as soon as conduction takes place, the voltage developed across resistor R32 causes the plate voltage of tube V205 to drop to approximately zero. This negative voltage change is transferred to the side of capacitor C214 that is connected to inductor L203 and causes the potential on the plate of tube V204 to become negative. When this happens, tube V204 stops conducting and halts the discharge of capacitors C208 and C209 the instant that the

capacitors reach zero, or ground potential. When tube V205 starts to conduct, oscillations are set up in the series-tuned circuit formed by capacitor C214 and inductor L203; however, when the voltage of the first oscillatory cycle drops to zero, tube V205 stops conducting. This opens the oscillatory circuit and any charge remaining on the side of capacitor C214 that is connected to inductor L203 is drained to ground through inductor L203 and resistor R209. The other side of capacitor C214 then charges to a potential of +130 volts from the +130-volt supply at resistor R32.

c. As soon as the potential on capacitors C208 and C209 reaches zero, the capacitors start to charge at a constant rate from the constant-current supply. The capacitors continue to charge until the end of the first selecting pulse (A, fig. 27). At this time, a space signal is received and the armatures of relays K4 and K5 operate to contact 5. Capacitors C208 and C209 are then connected to a reference voltage through the bias meter circuit and the total distortion meter circuit. If the transition occurs at the correct time, the potential on capacitors C208 and C209 will be equal to the reference voltage and no current will flow through the BIAS meter or the TOTAL DIST meter. If distortion is present, the transition will occur sooner or later than normal and the potential on capacitors C208 and C209 will be different from the reference voltage. In this case, current will flow through the BIAS meter and the TOTAL DIST meter and the meters will indicate the type and magnitude of distortion.

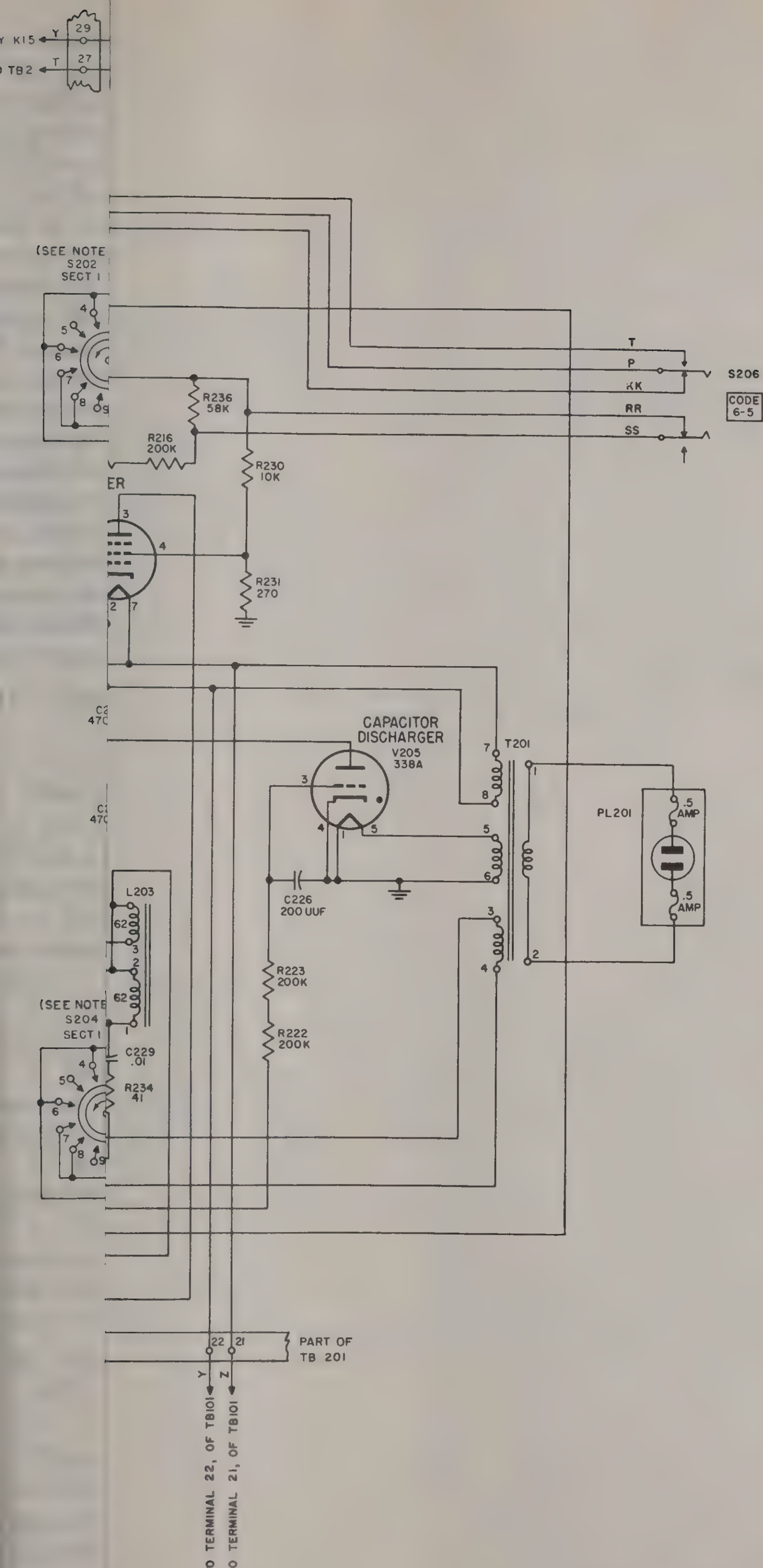
d. Capacitors C210 and C211, previously connected to the —55-volt reference voltage through the bias meter and total distortion meter circuits, are now connected to the constant-current supply and start to charge to a higher negative potential. At the proper instant, with respect to the start transition, tube V204 will be triggered by a positive pulse from the detector circuit and capacitors C210 and C211 will be grounded. When the potential on capacitors C210 and C211 reaches zero, the ground will be removed and the capacitors will charge from the constant-current supply until the next transition occurs, at which time the potential on capacitors C210 and C211 is compared with a reference voltage as described previously for capacitors C208 and C209.

e. For each transition (mark-to-space or space-to-mark), the charge on one set of measuring capacitors (C208 and C209 or C210 and C211) is connected to and compared with a reference voltage (par. 80). Capacitors C208 and C209, varistors CR201 through CR203, and relay K4 are associated with mark-to-space transitions; whereas, capacitors C210 and C211, varistors CR204 through CR206, and relay K5 are associated with space-to-mark transitions.

f. When a transition does not occur at the end of a selecting pulse, as is the case when a mark pulse is followed by another mark pulse (A, fig. 27), the measuring capacitors (C208 and C209 in this case) are grounded at the middle of the time duration allotted for each selecting pulse. For this reason, when the measuring capacitors are *finally* compared with the reference voltage, the constant-current supply will only have been charging the measuring capacitors for one-half the time duration of one selecting pulse as would have been the case if a transition had occurred between each selecting pulse.

g. Varistors CR207 through CR210 are connected between the constant-current lead and the —130-volt supply. They are poled so that the potential on the constant-current lead is never permitted to rise above —130 volts. If the potential on the constant-current lead tries to rise to a more negative potential than —130 volts, conduction takes place through the varistors and the —130-volt potential is maintained. If this precaution were not taken, the travel time of the armatures of relays K4 and K5 would present an open circuit to the constant-current lead and the potential on the lead would rise to —250 volts. Because no current would be flowing through resistor R208, both the grid and the cathode of tube V204 would be at —250 volts. This would permit tube V204 to fire falsely. To prevent this, varistors CR207 through CR210 conduct during this period and maintain the bias on the grid of tube V204.

h. Resistor R234 and capacitor C229 prevent tube V204 from going into high-frequency oscillation and possibly leaving a potential on the measuring capacitors. Resistor R32 is the plate supply resistor of tube V205. Resistor R20 is bridged across contacts 2 and 3 of relay K1 to furnish a potential to the cathode of tube V204 and thus prevent it from firing falsely between capacitor-discharging intervals.



NOTES:

1. ROTARY SWITCHES ARE VIEWED FROM END OPPOSITE CONTROL KNOB. SECTIONS DESIGNATED I ARE FURTHEST FROM THE KNOB.
2. UNLESS OTHERWISE SPECIFIED; RESISTORS ARE IN OHMS, CAPACITORS ARE IN UF.
3. FOR CONNECTIONS TO OTHER CIRCUITS, SEE OVERALL SCHEMATIC AND INTER-CONNECTION DIAGRAMS.
4. THESE CAPACITORS ARE FACTORY STRAPPED SO THAT THE COARSE SWITCHES WILL BE ON THE CENTER OF THEIR RANGE FOR EACH SPEED (60, 75, AND 100 WPM).

TM2224-61

capacitors reach zero, or ground potential. When tube V205 starts to conduct, oscillations are set up in the series-tuned circuit formed by capacitor C214 and inductor L203; however, when the voltage of the first oscillatory cycle drops to zero, tube V205 stops conducting. This opens the oscillatory circuit and any charge remaining on the side of capacitor C214 that is connected to inductor L203 is drained to ground through inductor L203 and resistor R209. The other side of capacitor C214 then charges to a potential of +130 volts from the +130-volt supply at resistor R32.

c. As soon as the potential on capacitors C208 and C209 reaches zero, the capacitors start to charge at a constant rate from the constant-current supply. The capacitors continue to charge until the end of the first selecting pulse (A, fig. 27). At this time, a space signal is received and the armatures of relays K4 and K5 operate to contact 5. Capacitors C208 and C209 are then connected to a reference voltage through the bias meter circuit and the total distortion meter circuit. If the transition occurs at the correct time, the potential on capacitors C208 and C209 will be equal to the reference voltage and no current will flow through the BIAS meter or the TOTAL DIST meter. If distortion is present, the transition will occur sooner or later than normal and the potential on capacitors C208 and C209 will be different from the reference voltage. In this case, current will flow through the BIAS meter and the TOTAL DIST meter and the meters will indicate the type and magnitude of distortion.

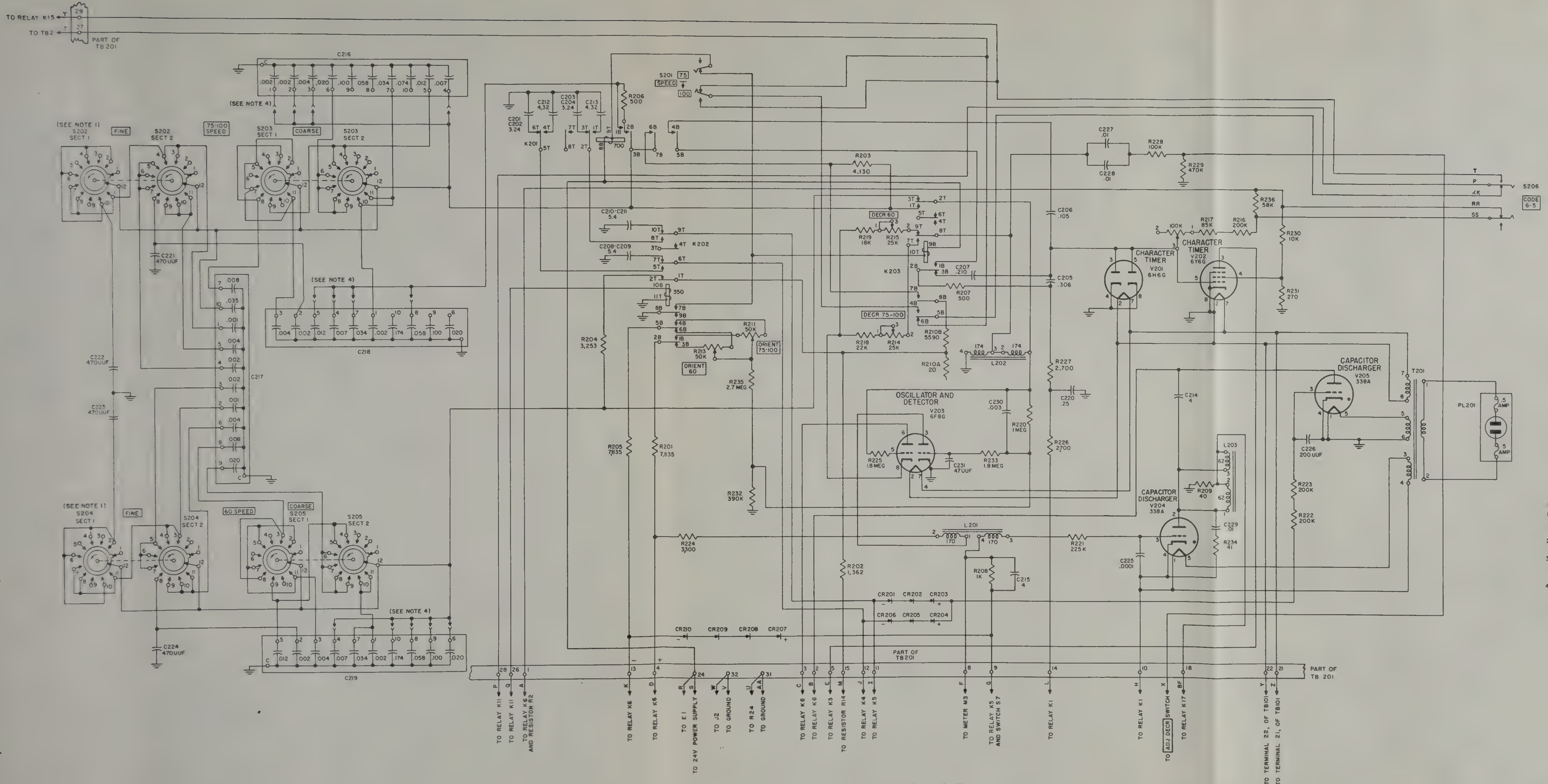
d. Capacitors C210 and C211, previously connected to the —55-volt reference voltage through the bias meter and total distortion meter circuits, are now connected to the constant-current supply and start to charge to a higher negative potential. At the proper instant, with respect to the start transition, tube V204 will be triggered by a positive pulse from the detector circuit and capacitors C210 and C211 will be grounded. When the potential on capacitors C210 and C211 reaches zero, the ground will be removed and the capacitors will charge from the constant-current supply until the next transition occurs, at which time the potential on capacitors C210 and C211 is compared with a reference voltage as described previously for capacitors C208 and C209.

e. For each transition (mark-to-space or space-to-mark), the charge on one set of measuring capacitors (C208 and C209 or C210 and C211) is connected to and compared with a reference voltage (par. 80). Capacitors C208 and C209, varistors CR201 through CR203, and relay K4 are associated with mark-to-space transitions; whereas, capacitors C210 and C211, varistors CR204 through CR206, and relay K5 are associated with space-to-mark transitions.

f. When a transition does not occur at the end of a selecting pulse, as is the case when a mark pulse is followed by another mark pulse (A, fig. 27), the measuring capacitors (C208 and C209 in this case) are grounded at the middle of the time duration allotted for each selecting pulse. For this reason, when the measuring capacitors are *finally* compared with the reference voltage, the constant-current supply will only have been charging the measuring capacitors for one-half the time duration of one selecting pulse as would have been the case if a transition had occurred between each selecting pulse.

g. Varistors CR207 through CR210 are connected between the constant-current lead and the —130-volt supply. They are poled so that the potential on the constant-current lead is never permitted to rise above —130 volts. If the potential on the constant-current lead tries to rise to a more negative potential than —130 volts, conduction takes place through the varistors and the —130-volt potential is maintained. If this precaution were not taken, the travel time of the armatures of relays K4 and K5 would present an open circuit to the constant-current lead and the potential on the lead would rise to —250 volts. Because no current would be flowing through resistor R208, both the grid and the cathode of tube V204 would be at —250 volts. This would permit tube V204 to fire falsely. To prevent this, varistors CR207 through CR210 conduct during this period and maintain the bias on the grid of tube V204.

h. Resistor R234 and capacitor C229 prevent tube V204 from going into high-frequency oscillation and possibly leaving a potential on the measuring capacitors. Resistor R32 is the plate supply resistor of tube V205. Resistor R20 is bridged across contacts 2 and 3 of relay K1 to furnish a potential to the cathode of tube V204 and thus prevent it from firing falsely between capacitor-discharging intervals.



NOTES

1 ROTARY SWITCHES ARE VIEWED FROM END OPPOSITE CONTROL KNOB. SECTIONS DESIGNATED 1 ARE FURTHEST FROM THE KNOB.

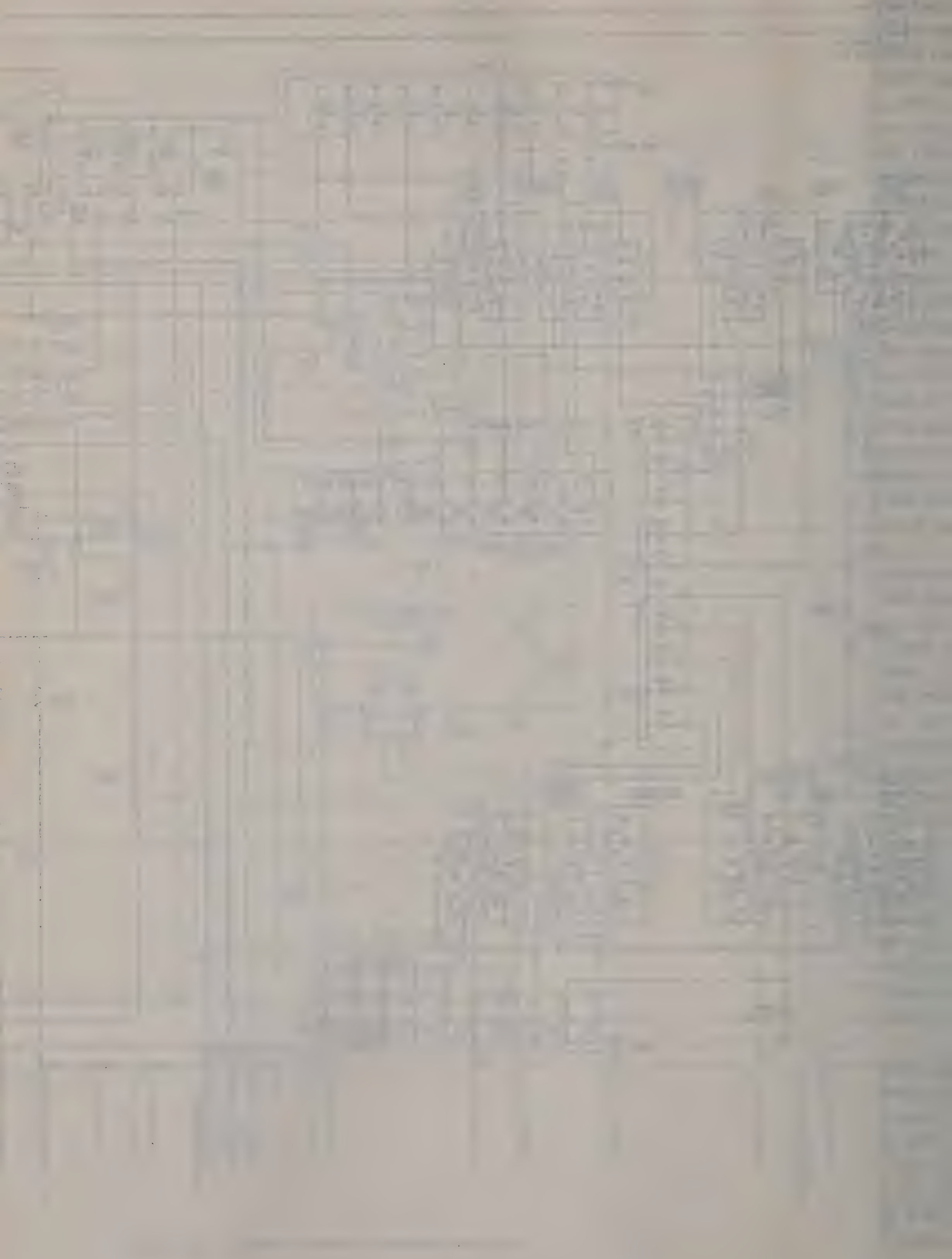
2 UNLESS OTHERWISE SPECIFIED, RESISTORS ARE IN OHMS, CAPACITORS ARE IN UF.

3 FOR CONNECTIONS TO OTHER CIRCUITS, SEE OVERALL SCHEMATIC AND INTER-CONNECTION DIAGRAMS.

4 THESE CAPACITORS ARE FACTORY STRAPPED SO THAT THE COARSE SWITCHES WILL BE ON THE CENTER OF THEIR RANGE FOR EACH SPEED (60, 75, AND 100 WPM).

Figure 28. Distributor circuit, schematic diagram.

TM2224-61



80. General

The teletypewriter test set can be arranged for testing teletypewriter circuits that are operating at speeds of 60, 66, 75, or 100 wpm. Two switches (CHG SPD and SPEED) are provided on the front of the teletypewriter test set so that it can be arranged for testing teletypewriter circuits operating at any one of these speeds. These switches control the operation of relays, which rearrange the connections to *some* of the resistors and capacitors in the distributor circuit and the measuring circuit of the teletypewriter test set. These connections are rearranged because the values of some of the resistors and capacitors are suitable for testing teletypewriter circuits that are operating at one speed but are not suitable for testing teletypewriter circuits that are operating at a different speed. Paragraphs 81 through 83 explain the conditions under which the various resistors and capacitors are used.

81. Circuit Elements Used for 60- or 66-wpm Operation
(figs. 26 and 29)

When the teletypewriter test set is arranged for 60- or 66-wpm operation, the CHG SPD switch and relays K201, K202, and K203 are unoperated.

a. Capacitors C208 through C211 are used as measuring capacitors in the comparison circuit.

b. Variable resistor R213 is used as the ORIENT potentiometer in the detector circuit.

c. Capacitors C205 and C207 are used to control the time delay in the character timer circuit.

d. Resistor R215 is used as the DECR potentiometer in the pulse oscillator circuit.

e. Capacitors C223 and C224, with parts of capacitors C217 and C219, are used to control the frequency of oscillation in the pulse oscillator circuit.

82. Circuit Elements Used for 75-wpm Operation
(figs. 26 and 29)

When the teletypewriter test set is arranged for 75-wpm operation, the CHG SPD switch is operated and the SPEED switch is operated to position 75. Relay K202 is operated because a circuit is completed from battery on the CHG SPD switch, through the winding of relay K202, to ground. Relay K203 is operated because a circuit is completed from battery, through the winding of relay K203, through closed contacts 7B and 8B of relay K202, to ground. Relay K201 is operated because a circuit is completed from battery, through the winding of relay K201, through the closed contacts of the SPEED switch, through closed contacts 7B and 8B of relay K202, to ground.

a. Capacitors C212 and C213 are used as measuring capacitors in the comparison circuit.

b. Variable resistor R211 is used as the ORIENT potentiometer in the detector circuit.

c. Capacitors C205 and C206 are used to control the time delay in the character timer circuit.

d. Resistor R214 is used as the DECR potentiometer in the pulse oscillator circuit.

e. Capacitors C221 and C222, with parts of capacitors C216, C217, and C218 are used to control the frequency of oscillation in the pulse oscillator circuit.

83. Circuit Elements Used for 100-wpm Operation
(figs. 26 and 29)

When the teletypewriter test set is arranged for 100-wpm operation, the CHG SPD switch is operated and the SPEED switch is operated to position 100. Relay K202 is operated because a circuit is completed from battery on the CHG SPD switch, through the windings of relay K202, to ground. Relay K203 is operated because a circuit is completed from battery, through the winding of relay K203, through closed contacts 7B and 8B of relay K202, to ground.

a. Capacitors C201 through C204 are used as measuring capacitors in the comparison circuit.

b. Variable resistor R211 is used as the ORIENT potentiometer in the detector circuit.

c. Capacitor C205 is used to control the time delay in the character timer circuit.

d. Resistor R214 is used as the DECR potentiometer in the pulse oscillator circuit.

e. Capacitors C221 and C222, with parts of capacitors C216, C217, and C218, are used to control the frequency of oscillation in the pulse oscillator circuit.

84. General

The rectifying peak voltmeter circuit rectifies the discharge currents from the measuring capacitors in the comparison circuit before these currents are applied to the TOTAL DIST meter (fig. 26). The circuit permits measurement of the magnitude of the *largest* distortion on the teletypewriter circuit under test, regardless of the type of distortion (bias, fortuitous, or characteristic). The circuit is designed so that the TOTAL DIST meter will retain its maximum indication for a reasonable length of time. Manual operation of the RESET switch, however, will *rapidly* restore the meter needle to its normal resting position.

85. Power Supply of the Rectifying Peak Voltmeter

(fig. 30)

a. Power for the rectifying peak voltmeter is obtained from a 115-volt, 60-cps, source and is connected to the primary winding of transformer T302 between terminals 1 and either 2, 3, or 4. When the teletypewriter test set is installed initially, the terminals on the transformer are connected to correspond with the line voltage available and should not require further change unless the magnitude of the line voltage changes. Any connection changes made to the terminals of the primary winding will change the magnitude of the voltage that appears in the secondary windings.

b. Winding 5–7 of transformer T302 is the source of filament voltage for tubes V301, V302, and V303 (2.5 volts). Resistors R301A and R301B (in parallel) are protective resistors for the filament circuits of tubes V301, V302, and V303. Winding 11–13 is the source of filament voltage for tube V304 (5 volts). Winding 8–10 is the source of plate voltage for tube V304.

c. The circuit for the dc output voltage of the power supply can be traced from ground, through resistors R319 and R320, through inductor L301, through windings 12–11 and 12–13 to the filament of tube V304, through tube V304 to one of its plates (terminal 2 or 3, depending upon the polarity of the applied voltage), through winding 8–9 or 10–9, through resistor R314, to ground. Capacitor C302 and inductor L301 filter the dc output. The dc potential that appears across capacitor C302 is 250 volts. With respect to ground, the potential on one plate of the capacitor is —50 volts and the potential on the other plate is +200 volts.

86. Wheatstone Bridge of the Rectifying Peak Voltmeter

(fig. 30)

a. Meter M2 (TOTAL DIST) is connected across the arms of a Wheatstone bridge circuit. The arms of the bridge are designated A, B, C, and D.

(1) Arm A consists of tube V203, jack J1 (RCRD), and resistors R305, R306, R307, R309, and R310. The RCRD jack can be used for connection to a recording device that will record the time, duration, and magnitude of distortions. Current in arm A varies when signal distortion is present in the circuit under test.

(2) Arm B consists of resistors R315, R316, R317, R318, R321, and R322.

(3) Arm C consists of resistor R313 and part of resistor R111 (ZERO ADJ potentiometer).

(4) Arm D consists of resistor R311 and part of resistor R111 (ZERO ADJ potentiometer).

b. The voltage developed across capacitor C302 (par. 85*c*) is applied to the Wheatstone bridge. The TOTAL DIST meter acts as the galvanometer and is shunted by resistors R23B and R110 (AMP ADJ potentiometer). The AMP ADJ potentiometer controls the sensitivity of the TOTAL DIST meter.

c. When the Wheatstone bridge is balanced, the resistance in arm A equals the resistance in arm B and the resistance in arm C equals that of arm D. In this case the resistance of tube V203 in arm A is approximately 21,000 ohms.

d. The bridge is balanced for a zero reading on the TOTAL DIST meter by adjustment of the ZERO ADJ potentiometer, when there is no signal input to the rectifying peak voltmeter. This adjustment is made while the RESET switch is operated (contacts closed). Operation of the RESET switch completes a circuit from battery through the winding of relay K301 and causes relay K301 to operate. When the contacts of relay K301 close, a ground is

DEPARTMENT OF THE ARMY
TECHNICAL MANUAL

DEPARTMENT OF THE AIR
FORCE TECHNICAL ORDER

TM 11-2240

TO 16-35MX306-5

See C2 3

WIRE DISPENSER

MX–306A/G

DEPARTMENTS OF THE ARMY AND THE AIR FORCE
OCTOBER 1951

AGO 1086B—Oct

TECHNICAL MANUAL

WIRE DISPENSER MX-306A/G

TM 11-2240 CHANGES No. 3 } HEADQUARTERS, DEPARTMENT OF THE ARMY
WASHINGTON 25, D.C., *9 March 1962*

TM 11-2240, 16 October 1951, is changed as follows:

Note. Parenthetical references to previous Changes (example: "page 3 of C 1.") indicates that pertinent material was published in that Changes.

Page 20. Make the following changes:

Figure 15 (page 3 of C 2). In upper center of A portion of illustration, change "1½" to: 1.

Paragraph 20.5, heading (page 5 of C 2). Change "MX-603A/G" to: MX-306A/G.

BY ORDER OF THE SECRETARY OF THE ARMY:

G. H. DECKER,
General, United States Army,
Chief of Staff.

Official:
J. C. LAMBERT,
Major General, United States Army,
The Adjutant General.

Distribution:

Active Army:

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USAAVNBD (1)
USAABELCTBD (1)
USAATBD (1)
ARADCOM (2)
ARADCOM Rgn (2)
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OS Base Comd (2)
LOGCOMD (2)
MDW (1)
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Corps (2)
Instl (2)
Ft Monmouth (63)
USATC AD (2)
USATC Armor (2)
USATC Engr (2)
USATC Inf (2)
USATC FA (2)
USAOMC (3)
Svc College (2)
Br Svc Sch (2)
GENDEP (2) except
Atlanta GENDEP (None)
Sig Sec, GENDEP (5)
Sig Dep (12)
WRAMC (1)
USA Trans Tml Comd (1)
Army Tml (1)
POE (1)
OSA (1)
USAEPG (2)
AFIP (1)
AMS (1)
Army Pictorial Cen (2)
EMC (1)
Yuma Test Sta (2)
USACA (3)
USASSA (20)
USASSAMRO (1)
USASEA (1)
USA Carib Sig Agcy (1)
USA Sig Msl Spt Agcy (13)
Sig Fld Maint Shops (3)
USA Corps (3)
Def Log Sup Cen (1)
JBUSMC (2)
1st GM Bde (5)
Units organized under following TOE's (2 each unless otherwise indicated):

1–7
5–5
5–6
5–7
5–8
5–278
6–300
6–301
6–315
6–316
6–317
6–319
6–325
6–326
6–327
6–328
6–329
6–330
7–25
7–26
7–27
11–7
11–16
11–55
11–57
11–58
11–85
11–87
11–97
11–117
11–155
11–157
11–500 AA–AE (4)
11–557
11–587
11–592
11–597
17
17–25
17–26
17–45
17–46

NG: State AG (3) units same as Active Army except allowance is one copy to each unit.

USAR: None.

For explanation of abbreviations used, see AR 320–50.

GPO 828348

TECHNICAL MANUAL

WIRE DISPENSER MX-306A/G

TM 11-2240
CHANGES No. 2

HEADQUARTERS,
DEPARTMENT OF THE ARMY
WASHINGTON 25, D.C., *14 October 1959*

TM 11-2240, 16 October 1951, is changed as follows:

(As changed by C 1, 23 Jul 56.) The following information changes TM 11-2240 so that the manual also applies to Wire Dispenser Case CY-1064A/ATC.

Page 1, chapter 1 (as changed by C 1, 23 Jul 56). Add the following note at the beginning.

Note. Wire Dispenser Case CY-1064A/ATC procured on Order No. 42945-Phila-56 is similar to Wire Dispenser Case CY-1064/ATC covered in the manual. Information covered in the technical manual applies equally to Wire Dispenser Case CY-1064A/ATC unless otherwise specified.

Page 5, paragraph 6*b*(2) (as changed by C 1, 23 Jul 56). Change the fifth sentence to read: Any number up to a maximum of four dispensers may be accommodated in the CY-1064/ATC; up to five dispensers may be accommodated in the CY-1064A/ATC.

Page 12, paragraph 13, (as changed by C 1, 23 Jul 56). Delete the second and third sentences and substitute the following: There are three types of aerial wire delivery containers: Wire Container CY-196/ATC, Wire Dispenser Case CY-1064/ATC, and Wire Dispenser Case CY-1064A/ATC. The use of the wire delivery containers permits the laying of a continuous circuit 2 miles in length when using the CY-1064/ATC, 2½ miles in length when using the CY-1064A/ATC, and 3 miles in length when using the CY-196/ATC.

Page 13, paragraph 14*b*(2), (as changed by C 1, 23 Jul 56). Change "four" to read "the."

Page 20. Add section V and figures 15 and 16 after section IV.

Section V. REFILLING WIRE DISPENSER MX-306A/G
(Added)

20.1. General

Empty Wire Dispensers MX-306A/G may be refilled by means of an easily contructed wire reel mounted on a reel axle. Refilling empty dispensers will enable units to maintain a standing supply of filled Wire Dispensers MX-306A/G and will prevent discarding empty dispensers otherwise serviceable.

*These changes supersede C 1, 23 July 1956.

20.2. Materials and Equipment Required

Quantity	Item
1 sheet	Plywood, ⅝-in., approximately 15 by 30 in.
4	Pipes, ½-in. ID, or seamless tubing, ¾-in. OD, 5½ in. lg.
8	Bolts, 5/16–18, 1 in. lg under head.
8	Flat washers, ⅜ in. ID.
8	Wing nuts, 5/16–18.
5 ft	Single-conductor field wire, or equivalent.
12 yd	Single-coated adhesive binding tape, 1 in wide.
1	Reel Axle RL–27 or RL–27–A or Reel Unit RL–31–(*).[1]

[1] Reel Unit RL–31–(*) represents Reel Units RL–31, RL–31–B, RL–31–C, RL–31–D, and RL–31–E.

20.3. Construction of Wire Reel

a. Cut and drill two plywood end pieces (A, fig. 15) and fabricate four tubular center posts (B, fig. 15).

b. Assemble the four center posts and one end piece (fig. 16) and secure the end piece to the center posts with flat washers and wing nuts.

20.4. Assembly of Wire Reel and Wire Dispenser MX–306A/G

a. Remove the adhesive binding tape from the periphery of an empty Wire Dispenser MX–306A/G. Remove the tape carefully because it will be needed for reuse.

b. Disassemble the wire dispenser by pulling the tabs of the canvas side panels away from the white tapes.

c. Place the side panel without tapes over the four center posts of the partially assembled wire reel so that the posts extend through the center hole in the side panel. Arrange the panel, printed side down, flat against the end piece of the wire reel. Note whether the panel is the STANDING END side panel or the PAYOUT END side panel of the dispenser. Fold back the loose edge of the side panel around the edge of the end piece and tape it in place.

d. Place the printed side of the remaining side panel of the dispenser flat against the other end piece of the wire reel. Orient the panel so that one of the D-rings is opposite the tab with the white stripe. Cut the white tape in several places, fold back the sections around the edge of the end piece, and tape them in place.

e. Place the second end piece on the free ends of the four center posts of the partially assembled wire reel (fig. 16). Secure the end piece to the centerposts with flat washers and wing nuts. Tighten all eight wing nuts securely.

f. Bring together the ends of a 5-foot length of single-conductor wire to form a loop. Insert the loop end through the ½-inch hole in the wire reel end piece that has the STANDING END panel of

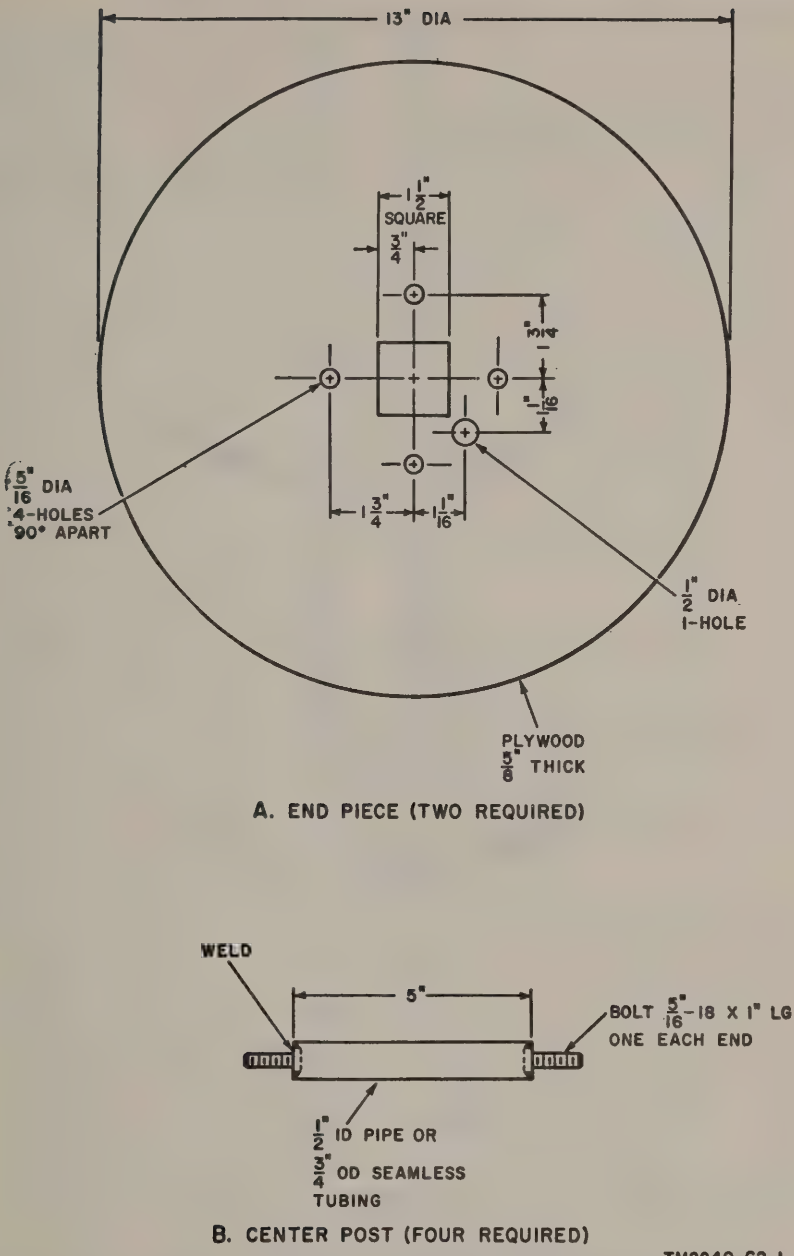

Figure 15. (Added) *Wire reel for refilling Wire Dispenser MX-306A/G, construction details.*

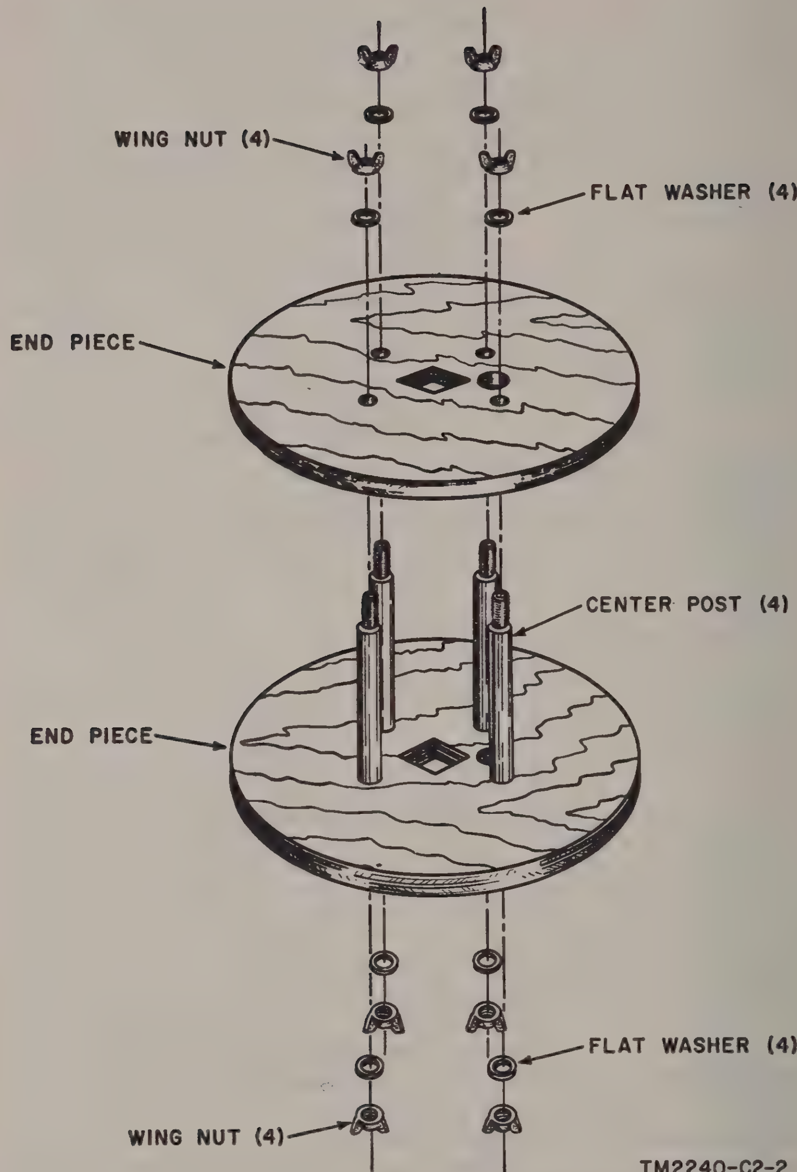

Figure 16. (Added) *Wire reel for refilling Wire Dispenser MX–306A/G, exploded view.*

the dispenser taped to it. Work the loop between the canvas panel and the end piece of the wire reel and then through the rubber grommet in the hole in the panel toward the inside of the wire reel. Pull about 20 inches of the loop through the grommet. Bring the loop and the free ends of the wire together and tape them to the

outside of the end piece of the wire reel. This wire will be used as a lead wire.

20.5. Winding Wire and Completing Refilling of MX–603A/G

a. Place the assembled wire reel and dispenser on Reel Axle RL–27 or RL–27–A or on the axle of a Reel Unit RL–31–(*). Place each end of the RL–27 or RL–27–A on a solid support so that the axle is horizontal and level. Be sure the wire reel can be turned freely between the supports without chafing. If Reel Unit RL–31–(*) is being used, mount the axle on the frame in the normal manner; remove the brake unit as when recovering wire.

b. Tape the *payout end* of the wire to be used to refill the MX–306A/G to one of the center posts of the wire reel. Secure the wire at the end of the center post and next to the PAYOUT END panel of the MX–306A/G.

c. Turn the crank on the reel axle and wind the wire on the wire reel. Turn the crank in the direction that will cause the wire to be drawn over the top of the wire reel. Guide the wire so that it is wound tightly and in such a manner that adjacent turns touch but never overlap. The winding must end at the STANDING END panel side of the wire reel.

d. When the wire reel is filled, detach the ends of the leader wire (par. 20.4*f*) from the end piece of the wire reel. Unwind the last 4 feet of the wire on the reel and pass about 3 feet of this wire through the loop of the lead wire.

e. Pull the free ends of the lead wire and draw the loose end of the wire wound on the reel (*d* above) between the canvas side panel of the dispenser and the wound wire and out through the hole in the wire reel end piece. At least 30 inches of the wire should be outside the reel; this is the *standing end* of the coil of wire.

f. Fold the white-taped sections of the side panel of the dispenser around the coiled wire and press them firmly into place. Then fold the tabs and the edge of the opposite panel over the white tapes; pass the tab with the white stripe and the opposite tab through the D-rings. Press all tabs into place and then tape them tightly with the original adhesive binding tape (par. 20.4*a*).

g. Apply a final covering of new single-coated adhesive binding tape. Wind the tape tightly with each turn overlapping the previous turn by 50 percent. Be sure to leave the D-rings outside the tape.

h. Remove the refilled dispenser and the wire reel from the reel axle. Remove the wing nuts and flat washers that secure one end piece of the wire reel and remove the end piece. Pull the refilled dispenser off the center posts of the wire reel and detach the *payout end* of the coiled wire from the center post to which it was taped.

i. Coil the *payout end* of the wire and tuck it inside the dispenser on the PAYOUT END side. Coil the *standing end* of the wire and tuck it inside the dispenser on the STANDING END side.

[AG 300.7 (25 Sep 59)]

By Order of *Wilber M. Brucker*, Secretary of the Army:

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11–57 (2)
11–97 (2)
11–117 (2)
11–155 (2)
11–500 AA–AE (2)
11–557 (2)
11–587 (2)
11–592 (2)
11–597 (2)

NG: None.

USAR: None.

For explanation of abbreviations, see AR 320–50.

GPO 964552

TM 11-2240—TO 16-35MX306-5

This manual supersedes TM 11-2240, January 1947, and C1, 8 August 1949.

WIRE DISPENSER

MX-306A/G

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DEPARTMENT OF THE ARMY
WASHINGTON 25, D. C., *16 October 1951*

TM 11-2240/TO 16-35 MX 306-5 is published for the information and guidance of all concerned.

[AG 300.7 (17 Sep 51)]

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For explanation of distribution formula, see SR 310-90-1.

CONTENTS

Figure 1. Methods of using Wire Dispenser MX–306A/G.

This manual supersedes TM 11–2240, 27 January 1947, and C1, 8 August 1949.

CHAPTER 1
INTRODUCTION

Section I. GENERAL

1. Scope

a. This technical manual contains instructions for the installation and operation of Wire Dispenser MX–306A/G. Maintenance instructions are not included because the equipment is expendable.

b. The appendix contains a list of applicable references.

2. Forms and Records

The following forms will be used for reporting unsatisfactory conditions of Army equipment.

a. DD Form 6, Report of Damaged or Improper Shipment, will be filled out and forwarded as prescribed in SR 745–45–5 (Army), NAV DEPT SERIAL 85P00 (Navy), and AFR 71–4 (Air Force).

b. DA AGO Form 468, Unsatisfactory Equipment Report, will be filled out and forwarded to the Office of the Chief Signal Office, as prescribed in SR 700–45–5.

c. AF Form 54, Unsatisfactory Report, will be filled out and forwarded to Commanding General, Air Matériel Command, Wright-Patterson Air Force Base, Dayton, Ohio, as prescribed in SR 700–45–5 and AFR 65–26.

d. Use other forms and records as authorized.

Section II. DESCRIPTION AND DATA

3. Purpose and Use

a. Wire Dispenser MX–306A/G is an expendable canvas container which houses a ½-mile coil of Wire WD–1/TT or WD–14/TT. The wire may be payed out smoothly at all speeds up to about 100 miles per hour. The dispenser is designed to permit the establishment of wire communication circuits without the use of auxiliary equipment when definite limitations must be placed on the weight and space requirements of the wire-laying equipment. The dispenser is constructed so that it can be air-dropped for emergency delivery to troops in the field by tying several dispensers together and using a light cargo delivery parachute. In extreme emergencies, individual dispensers may be delivered to ground troops by a free-fall drop.

Although the units may become distorted in shape or the side walls may split, satisfactory payout still may be achieved.

b. Wire can be laid from Wire Dispenser MX–306A/G by mountain, ski, or ground troops by the use of a hand or shoulder sling or an infantry packboard.

c. Wire can be payed out from any land vehicle, amphibious vehicle, liaison-type airplane, or helicopter.

d. Dispensers can be used one at a time or connected in tandem.

e. Under special conditions, wire can be payed out for short distances by means of bazookas or rifles, using bazooka projectiles or rifle grenades.

f. The speed at which wire may be payed out ranges from the slowest hand-carry by ground troops to a speed of about 100 miles per hour.

4. Physical Characteristics

a. Wire Dispenser MX–306A/G (fig. 2) is a cylindrical container made of canvas and tape. There is a 4-inch circular opening through the center of the coil for wire payout. Each side wall opening is provided with a rubber grommet to provide a smooth, resilient edge for payout. Also, the dispenser is provided with D-rings, spaced 90° apart on the periphery, for lashing to a packboard or vehicle. Handle ST–118/G may be used to carry the dispenser, or an emergency carrying table can be devised by using a short length of the wire from the dispenser and tying it through two of the D-rings. Short lengths of the wire can be used to lash the dispenser where required.

b. Wire Dispenser MX–306A/G contains a maximum of 2,775 feet or a minimum of 2,500 feet (approximately ½ mile) of either Wire WD–1/TT or Wire WD–14/TT. These types of wire are identical except for the jacket used. The length and type of wire within a dispenser are stenciled plainly on the outside of the dispenser (fig. 2). During payout, a sticky substance may be observed on the jacket. This substance is applied during manufacture to give layer-to-layer restraint to the wire to prevent free-running payout. Payout is from one head only; the head marked PAYOUT END. The other head is marked STANDING END. The standing end of the wire is run from the periphery of the coil under the side wall to the inner opening of the head. At both the STANDING END and PAYOUT END, a 24-inch length of the wire is coiled and is placed inside the 4-inch opening, which is covered on both ends by a square of adhesive tape (fig. 2). When payed out, the wire usually lies flat, but, in some instances, a slight helical set may remain. This is not considered an unsatisfactory condition; a small amount of tension on the wire will cause it to lie flat and remain in a flat condition.

Note. Wire WD–1/TT manufactured before 1949 may develop cracks in the nylon jacket when it is payed out by aircraft at extremely low temperatures (below −35°F.) and at moderately high speeds (80 to 85 miles per hour). If the nylon jacket is cracked, the wire may be used *only* if the polyethylene insulation is continuous; the transmission characteristics will be unaffected. Wire WD–14/TT is unaffected by payout at low temperatures and high speeds.

c. When loaded with wire and ready for use, the dispenser weighs approximately 27 pounds and is 5 to 5½ inches thick and 13 to 13½ inches in diameter.

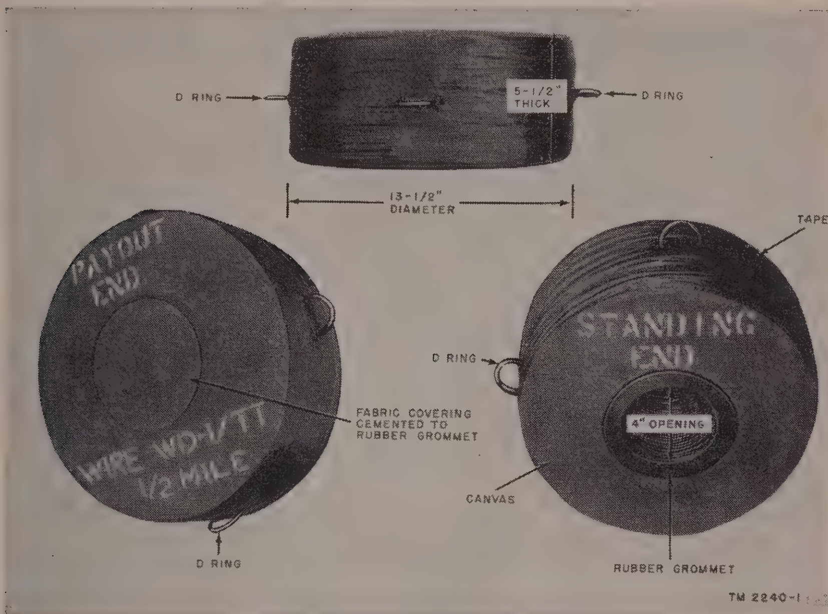


Figure 2. Wire Dispenser MX–306A/G.

5. Packaging Data

When packaged for export shipment, each dispenser is contained in a cardboard carton, which in turn, is wrapped in a waterproof barrier. Each export shipping container contains four of the packaged dispensers. The shipping container weighs 130 pounds and has a volume of 3.5 cubic feet.

6. Additional Equipment Required

No special mounting devices are necessary if one wire dispenser is to be used to lay wire, either on foot or from a vehicle. Special devices are necessary if two or more dispensers, connected in tandem, are to be mounted for vehicular or aircraft wire laying. Some means must be provided so that the dispensers can be supported and alined one behind the other.

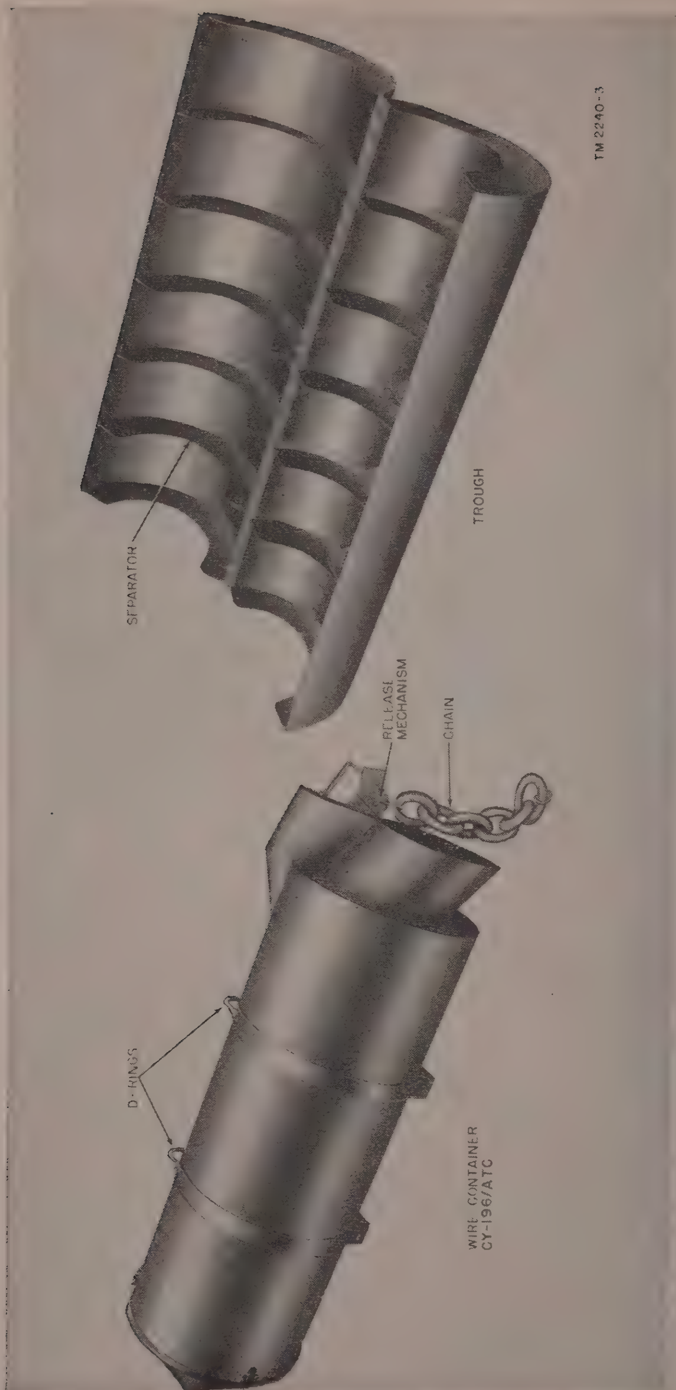


Figure 3. Wire Container CY-196/ATC.

a. IMPROVISED JIG FOR VEHICULAR USE. There is no special equipment provided for vehicular wire laying using wire dispensers connected in tandem. Improvise a jig from scrap lumber or metal which will insure that the dispensers are alined and braced properly. Figure 6 shows one type of jig for use with three dispensers. It is not necessary, however, to construct so elaborate an equipment. Paragraphs 9 and 10 describe detailed methods of using the improvised jig.

b. SPECIAL DEVICES FOR AIRCRAFT USE.

(1) *Wire Container CY–196/ATC* (fig. 3). This container is a tubular metal housing designed to facilitate aerial wire-laying from Wire Dispensers MX–306A/G by use of the L–5 fixed-wing Army aircraft and the H–13D and H–23 helicopters. Any number up to a maximum of six wire dispensers may be accommodated simultaneously. A switch is provided on the instrument panel of the aircraft to enable the pilot to operate a solenoid and effect the start of the wire laying by releasing a weight attached to the payout end of the wire. Refer to paragraphs 14 and 15 for detailed instructions for the use of this equipment.

(2) *Wire Dispenser Case CY–1064/ATC* (fig. 4). This is a jettisonable, cylindrical canvas case, reinforced with aluminum plates. A full length zipper is provided to facilitate

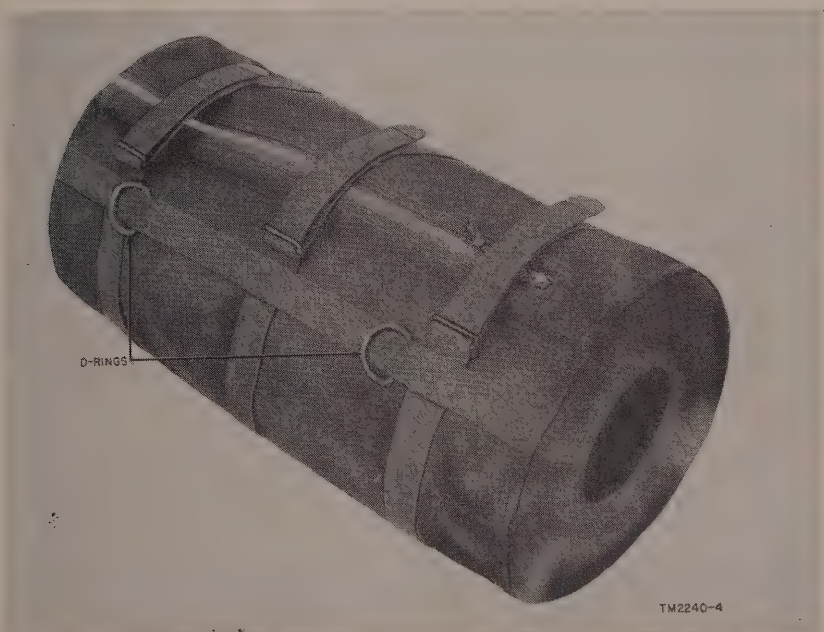


Figure 4. Wire Dispenser Case CY–1064/ATC.

the insertion and removal of dispensers. The equipment is expendable. The CY–1064/ATC is designed for use with the L–5 and L–19 fixed-wing Army aircraft and with the H–13D and H–23 helicopters. Any number up to a maximum of four dispensers may be accommodated. The start of payout is effected by the manual release, over the side of the aircraft, of a weight attached to the payout end of the wire. Refer to paragraphs 14 and 15 for detailed instructions for the use of this equipment.

CHAPTER 2
OPERATING INSTRUCTIONS

Section I. PREOPERATIONAL PROCEDURES

7. Uncrating, Unpacking, and Checking New Equipment

a. GENERAL. The equipment may be shipped in oversea packing cases or in domestic packing cases. The instructions in *b* below apply to equipment shipped in export packing cases. The procedure is identical for domestic packing cases, except that no moistureproof barrier is provided.

b. STEP-BY-STEP INSTRUCTIONS FOR UNCRATING AND UNPACKING EXPORT SHIPMENTS.

(1) Cut and fold back the steel straps.

(2) Remove the nails with a nail puller. Remove the top and one side of the packing case. Do not attempt to pry off the sides and top.

(3) Remove the moistureproof barrier and any packing material covering the equipment inside the case. No special precautions are necessary when opening the waterproof paper barrier and removing the equipment from the cardboard carton.

(4) Inspect the equipment for possible damage incurred during shipment.

Caution: Do not remove the fabric which covers the openings in the sides of the wire dispenser until preparations are made to pay out wire.

c. CHECKING. Check the contents against the master packing slip.

Note. Save the original packing cases and containers. They can be used again if it is necessary to repack the equipment for storage or shipment.

8. Preparation for Use

a. Remove the covers from the standing and payout ends, and pull out the 24-inch lead from each opening.

b. Test the coil for continuity as follows:

(1) Strip the insulation for a distance of about 1 inch from both pairs.

(2) Twist together the bare wires of one pair, and apply a battery and test lamp, a field telephone, an ohmmeter, or any other satisfactory means that is available, to the bare wires at the other end.

(3) If continuity is not indicated, see that the bare wires at the other end are contacting, and test again. Reject the dispenser if continuity still is not indicated.

c. Test the coil for short circuits as follows:

(1) Untwist the wires at both ends and be certain that none of the bare leads is touching another.

(2) Test for continuity.

(3) If continuity is indicated, the coil is shorted. Do not use any shorted dispenser except in an emergency, and in no case where the projected telephone line will cross any body of water.

Section II. GROUND WIRE-LAYING PROCEDURES

Caution: Test all dispensers for continuity and for short circuits (par. 8) before starting any wire-dispensing procedures.

9. Signal-dispenser Operation on Foot or by Vehicle

Wire may be payed out by anchoring the payout end of the wire and by transporting the dispenser toward the desired location. Payout is from the center of the coil outward. *Always operate the dispenser so that payout is from the end marked PAYTOUT END.*

a. For the dispensing of a single coil of wire, the dispenser may be transported by any suitable means. A single dispenser may be lashed to an infantry packboard, or carried by a shoulder sling, or carried by the canvas strap handle. The packboard or sling may be used for dispensing by mountain, ski, or ground troops. (See figure 1, lower left-hand corner.)

b. A single dispenser may be mounted on and transported by any land or amphibious vehicle. Two dispensers, mounted side-by-side, may be used when it is desired to lay two parallel wire systems.

c. Communication may be maintained throughout payout. Install a Telephone EE–8–( ) at the payout end and install another EE–8–( ) at the standing end. This will enable communication to be maintained between personnel at the fixed end of the wire and those either hand-carrying the dispenser or occupying the vehicle which is transporting the dispenser.

10. Tandem-dispenser Operation for Vehicles

a. Necessity for Tandem Coil Operation. Two or more dispensers may be connected in tandem when it is desired to lay more than one coil of wire without stopping to make a splice. For ground wire-laying, tandem coil operation usually is restricted to a vehicle of some sort.

b. Improvised Jig. Construct a jig of sufficient size to hold the desired number of dispensers. The jig should meet the requirements outlined in paragraph 6*a*. Figure 6 shows one type of improvised jig.

c. Installation of Dispensers in Jig.

(1) Set the payout end of the first wire dispenser flush against one end of the jig. This end will be designated as the payout end. The other end of the jig will be designated as the standing end.

(2) Place the payout end of the second dispenser about 6 inches away from the standing end of the first dispenser.

(3) Pull out just enough wire from the standing end of the first dispenser and from the payout end of the second dispenser to enable a standard splice to be made (fig. 5). Be certain that the spliced joints are staggered, that the over-all diameter of the splice is as small as possible, and that there is equal tension on all conductors of the splice.

(4) Not more than 6 inches of wire should be left loose between the two coils. Secure the surplus wire at the standing end of the first dispenser by coiling the wire and by taping the coil to the standing side of the dispenser with the tape which originally covered the center of the coil (fig. 5). Follow the same procedure for the surplus wire at the payout end of the second dispenser.

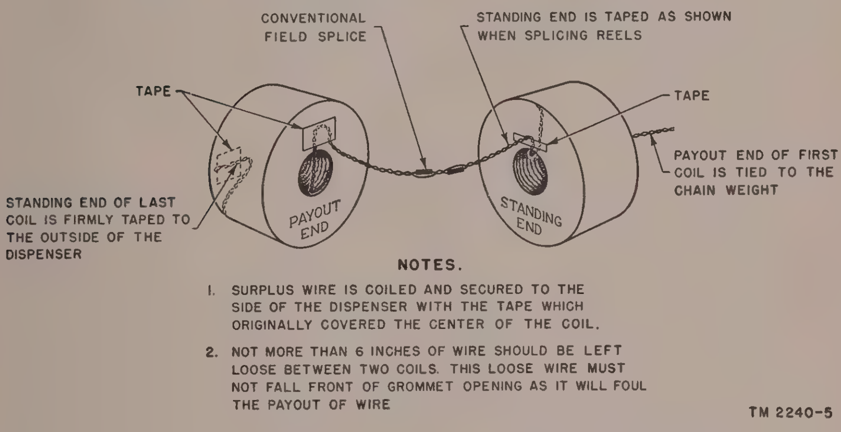


Figure 5. Wire Dispensers MX–306A/G, splice for tandem operation.

(5) Slide the second dispenser flush against the first dispenser.

(6) Pull all of the slack, resulting from the splicing process, back neatly into the second dispenser. This is done to prevent snagging the spliced wire during payout.

(7) Repeat the procedures described in (1) through (6) above for any additional dispensers.

(8) After all dispensers are installed on the jig, lash them in position. Figure 6 shows dispensers in an improvised jig.

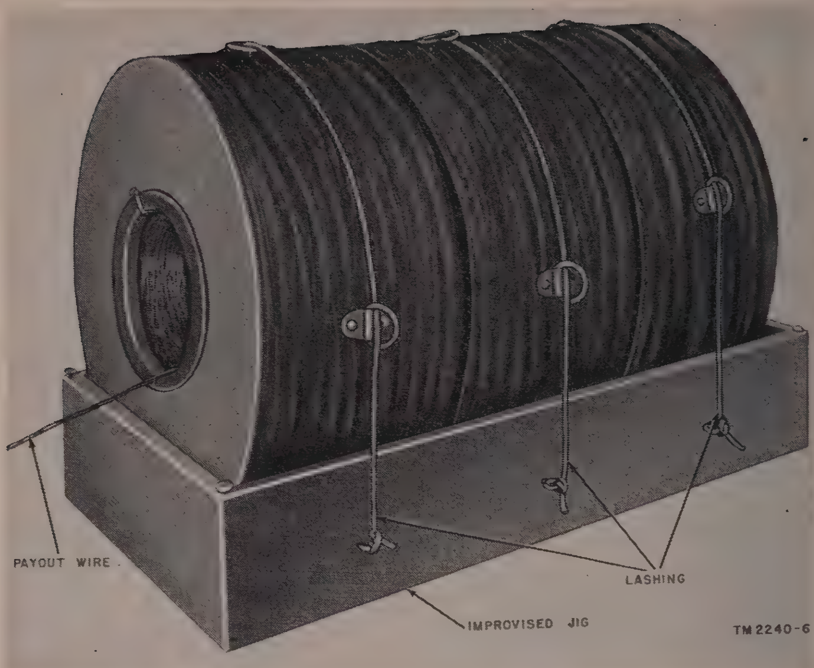


Figure 6. Wire Dispensers MX–306A/G, connected in tandem and lashed to improvised jig.

d. TESTING OF SPLICED DISPENSERS.

(1) After completing the installation of the dispensers in the jig, make a test for continuity of the circuit from the payout end of the first dispenser to the standing end of the last dispenser.

(2) If tests reveal that the circuit is open, unlash the dispensers and check the splices. If a faulty splice is found, resplice and recheck it.

(3) If necessary, recheck the individual dispensers for continuity until the trouble is located. Replace any defective dispenser with a good, tested dispenser.

(4) Lash the dispensers back in the jig.

e. INSTALLATION OF JIG IN VEHICLE. The method of installation of the loaded jig depends on the type of vehicle to be used. *The payout end of the jig must be mounted so as to face toward the rear.* Figure 7 shows a jig in a typical vehicular installation. The standing end lead of the assembly is connected to a Telephone EE–8–B for communication during payout. Two or more jigs loaded with dispensers connected in tandem may be used at the same time in the same vehicle to lay two or more parallel circuits.

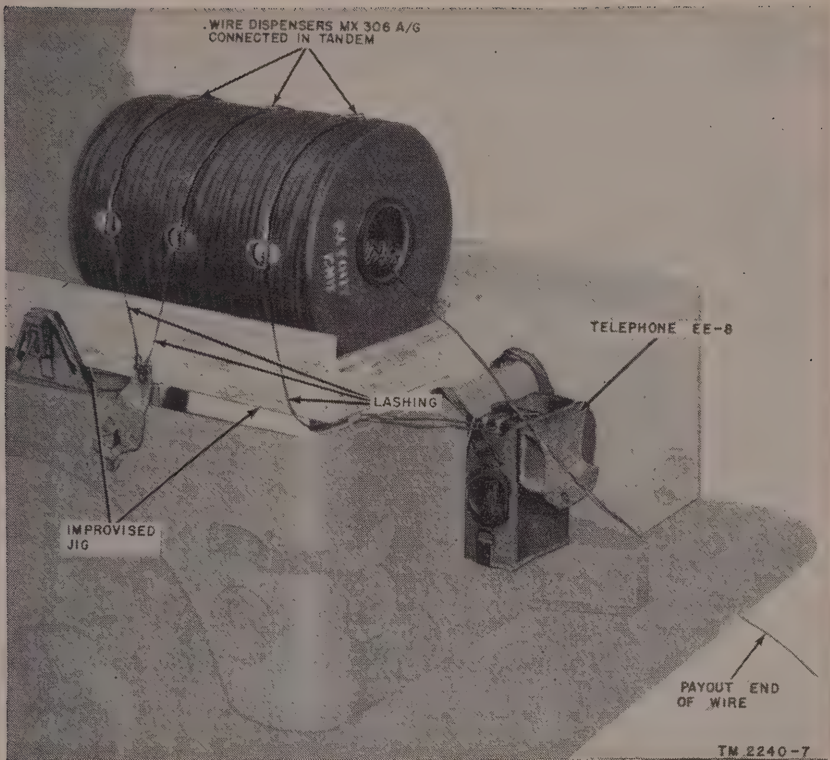


Figure 7. Wire Dispensers MX–306A/G, connected in tandem in typical vehicular installation.

11. Vehicular Wire-Laying Techniques

a. If possible, drive the vehicle in as straight a path as is consistent with the terrain and tactical situation. This will help to prevent excessive lengths of wire being laid for a particular circuit.

b. Lay the wire as close to the side of the road as is practicable.

c. When wire is laid one dispenser at a time and spliced after payout, test the wire that has been laid before splicing it to the wire of a new dispenser.

Section III. AERIAL WIRE-LAYING PROCEDURES

12. Warning Notice

The safety precautions listed below must be understood thoroughly before beginning the actual aerial wire-laying procedure. Failure to observe these precautions may result in torn wires, in the crashing of the aircraft and possible death to the occupants, or in injury or death to ground personnel.

a. Always maintain the speed of fixed-wing aircraft at least 20 miles above the stalling speed. Normal cruising speed is recommended.

b. Always tape the standing end lead of each dispenser to the side wall of the dispenser.

c. Place a thin cardboard separator between each dispenser to prevent fly-back of the wire which is being payed out. Cut a small hole, approximately 1 inch in diameter, opposite the standing end. Tape the standing end lead back to the side wall and draw the end through the hole. Make the splice on the side nearest the next dispenser.

d. To jettison the entire wire delivery container, operate the push-button control that operates the solenoid in the S–2 and D–820 bomb shackles.

13. General

Wire Dispensers MX–306A/G can be connected in tandem and the wire payed out from special aerial wire delivery containers (par. 6) attached either to liaison-type airplanes or to helicopters. There are two types of aerial wire delivery containers: Wire Container CY–196/ATC and Wire Dispenser Case CY–1064/ATC. The use of the wire delivery containers permits the laying of a continuous circuit 2 miles in length when using the CY–1064/ATC and 3 miles in length when using the CY–196/ATC. These containers are secured to bomb shackles underneath the wings of the liaison-type airplanes by means of D-rings built into the case of the containers. A special mounting is required for helicopter use. One container may be mounted under each wing of fixed-wing aircraft; the containers may be payed out one at a time or simultaneously.

14. Installation of Dispensers in Delivery Containers

Note. Wire Container CY–196/ATC usually will be installed permanently on the aircraft.

a. Wire Container CY–196/ATC. Each container is equipped with a hinged cylindrical trough which contains rigid barriers. The barriers are positioned between each dispenser in such a manner as to prevent sidewise collapse of the dispensers when the wire is payed out and to prevent shifting of the dispensers, in flight, when less than the maximum number is used. This trough may be taken out of the container after the removal of the container nose. The trough is used as a jig to support and line up the wire dispensers.

(1) Open the latches which hold the nose of the container in place; remove the nose and slide the trough out of the container.

(2) Install the wire dispensers in the trough in a manner similar to that described in paragraph 10*c*.

(3) Check the circuit from the payout end of the first dispenser to the standing end of the last dispenser as described in paragraph 10*d*.
(4) After continuity has been established, put the loaded trough in the container and replace the nose.

b. WIRE DISPENSER CASE CY–1064/ATC.
(1) Zip open the canvas case and insert the two 6-inch wide curved aluminum reinforcing strips in the pockets at the top and bottom of the bag.
(2) Splice four wire dispensers together as described in paragraph 10.
(3) Test for continuity as described in paragraph 10*d*.
(4) Tape the standing end lead of the last dispenser to the side wall.
(5) Close the zipper and secure the three canvas straps.

15. Installation of Delivery Containers on Aircraft

a. GENERAL. Special mountings (fig. 8) are provided to install the delivery containers on aircraft. The mountings provided on each of the aircraft used for aerial wire-laying are described in (1) through (3) below.
(1) *L–5 Army aircraft.* An S–2-type bomb shackle (Air Force stock No. 6400–621535–94) is mounted on the wing struts next to the jury brace. This bomb shackle operates on either 12 or 24 volts. The delivery containers are mounted on the bomb shackle by D-rings built into the case.
(2) *L–19 Army aircraft.* The L–19 airplane is equipped with nut plates for the installation of the S–2-type bomb shackle. The D–820-type bomb shackle (Air Force stock No. 6400–695168–3, Class II) also may be used on this airplane. This equipment operates on 24 volts only.
(3) *H–13D and H–23 helicopters.* A special bracket has been designed to mount either the S–2-type or the D–820-type bomb shackle on the helicopters.

b. INSTALLATION OF WIRE CONTAINER CY–196/ATC (fig. 9.)
(1) Trip the bomb shackle open.
(2) Place the D-rings of the container inside the shackle latches.
(3) Close the shackle latches by pushing them with a screw driver.
(4) Tighten the screws on the sway brace to eliminate any sidewise movement.
(5) Connect the payout lead of the first dispenser to a 6-pound weight. (A 6-pound section of chain which has a small link at one end may be fashioned for this purpose.)
(6) Push in on the solenoid and open the release mechanism.

Figure 8. D–820 bomb shackle mounted on L–19 Army aircraft.

(7) Connect the weight (or the small link of the chain) to the release mechanism and restore the solenoid to the normal position.

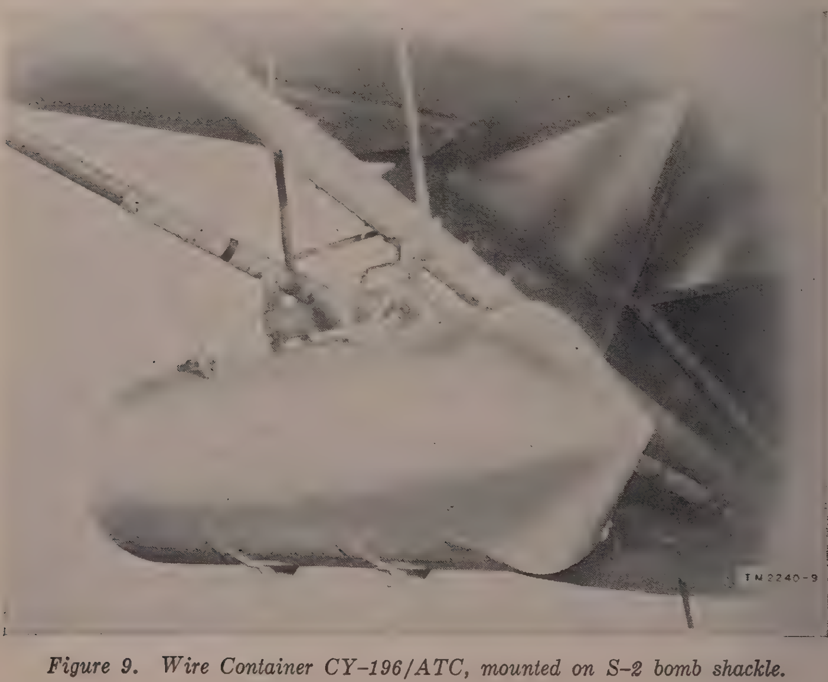


Figure 9. Wire Container CY–196/ATC, mounted on S–2 bomb shackle.

c. INSTALLATION OF WIRE DISPENSER CASE CY–1064/ATC (fig. 10).

(1) Trip the bomb shackle open.

(2) Place the D-rings of the containers inside the shackle latches.

(3) Close the shackle latches by pushing them with a screw driver.

(4) Pull out the payout end of the wire from the rear of the container and tie on a 6-pound weight. (Use a message drop filled with shot or scrap metal.)

(5) Place the lead, with the weight attached, in the cockpit. Use a piece of the tape covering the end of a dispenser to tape the wire to the outside of the rear end of the dispenser case. This will prevent payout of the wire until the weight is dropped.

Figure 10. Wire Dispenser Container CY–1064/ATC, mounted on S–2 bomb shackle.

16. Payout Procedures

a. WIRE CONTAINER CY–196/ATC. A switch is provided on the instrument panel of the aircraft to actuate a solenoid connected to the hinged cover of the wire container. Actuation of this solenoid opens the hinged cover. This allows the weight attached to the payout lead to drop out of the container.

b. WIRE DISPENSER CASE CY–1064/ATC. To start payout, drop the weight attached to the payout lead overboard. *Be certain that the weight is dropped behind the wing struts.*

17. Aerial Wire-laying Technique

a. LAYING WIRE OVER MOUNTAINOUS TERRAIN. Fly as slowly and as near to the ground as is practicable. (Refer to the warning notice (par. 12).) This should be done to minimize the damage that might be sustained by the wire when it is payed out over mountainous terrain. If the altitude is too great, excessive slack is formed in the wire; this will shorten the communication distance in straight-mile length and increase the possibility of circuit failure.

b. LAYING WIRE OVER NONMOUNTAINOUS TERRAIN. In general, wire laid over nonmountainous terrain (jungles, plains, forests, desert, and water) is less subject to damage than when laid over mountainous terrain. Here again, the airplane should be flown as slowly and as low as possible to prevent the formation of long aerial loops of wire. (Refer to the warning notice (par. 12).)

c. STARTING PAYOUT OF WIRE. Payout from an airplane can be started at the moment of take-off by first anchoring the payout end of the wire. Payout also can be started at any point after flight has begun. The pilot must fly over a prescribed target and operate the release control or throw the weight overboard.

d. ESTABLISHING COMMUNICATION. Since two circuits are laid at the same time, the chances are that at least one talking circuit will be established. Advance arrangements should be made, between the two points of communication, regarding the technique to be followed for establishing communication over the pairs of wires. The procedure below is typical and may be used as a guide.

(1) Use each pair of wires as the metallic portion of a ground-return circuit. This will provide two ground-return circuits for checking the circuit for the first time. Two telephone rods and two ground rods are required at each end of the line. The use of each pair of wires as the metallic part of a ground-return circuit will make it possible to establish a talking circuit when one conductor of a twisted pair of wires is broken or short-circuited. If a talking circuit cannot be established by the use of ground-return circuits, it must be assumed that the lines have broken during payout.

(2) After initial contact has been made, test each circuit to determine if a metallic circuit can be established over each twisted pair. In addition, each wire of a twisted pair may be used as one leg of a ground-return circuit.

Section IV. OPERATION UNDER UNUSUAL CONDITIONS

18. General

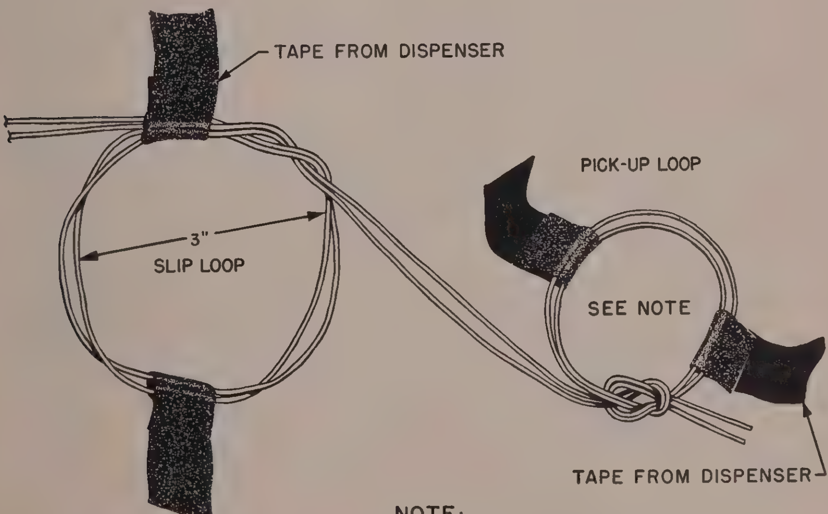
Under some conditions, communication between points 70 to 100 yards apart may be desirable. Wire can be payed out from Wire Dispensers MX–306A/G, using either a bazooka or a rifle and rifle grenade. Neither of these methods is very reliable and should not be used except under extreme emergency.

19. Laying Wire with Bazooka

Wire can be payed out by attaching the payout end lead to the muzzle of a bazooka and firing the bazooka. The bazooka projectile engages the wire and carries it to the desired destination.

a. Form a pick-up loop (fig. 11) in the payout end of the wire. Tie the wire, using a square knot or any other knot that will not slip, in a tight loop around the cylindrical portion of the projectile. Slip the loop from the projectile and tape it in the center of the muzzle opening of the bazooka (fig. 12). Use the tape which originally covered the center opening of the dispenser.

b. Tie a slip loop (fig. 11), about 3 inches in diameter, 7 inches from the pick-up loop. Tape this loop to the muzzle of the bazooka (fig. 12).



NOTE:
FORM PICK-UP LOOP BY TYING WIRE AROUND THE NOSE OF THE PROJECTILE. TIE A SQUARE KNOT AND REMOVE PICK-UP LOOP FROM PROJECTILE.

TM 2240-11

Figure 11. Pick-up and slip loops in wire for use with bazooka.

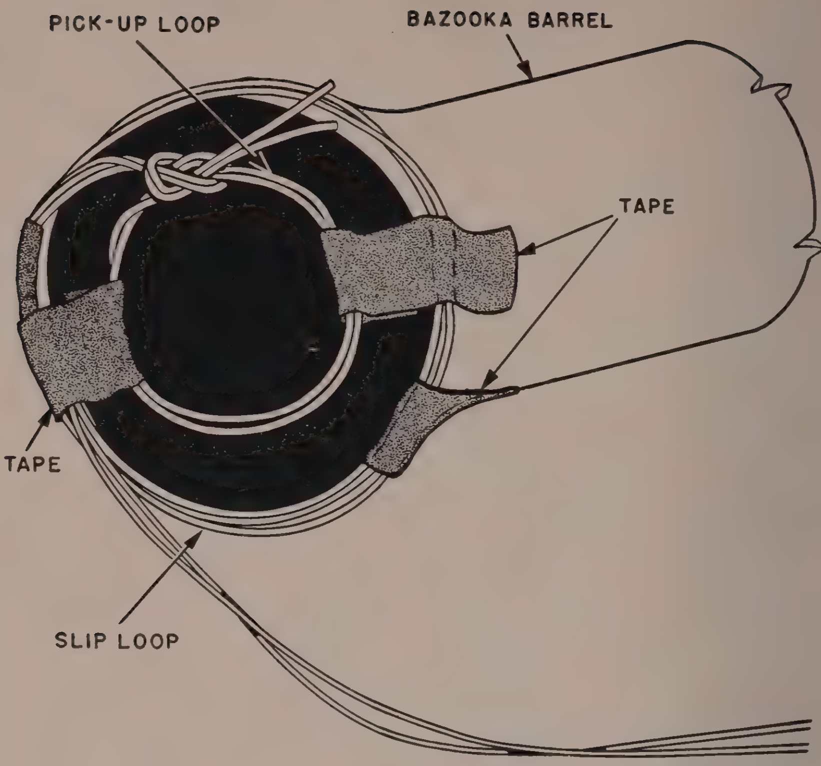


Figure 12. Pick-up and slip loops taped in position on bazooka barrel.

c. Pull 60 feet of wire out of the dispenser; this constitutes slack. Arrange this wire so that it extends some 30 feet in front of the dispenser and then back to the bazooka muzzle. This will allow a certain amount of slack to be taken up by the projectile. If this is not done, the wire may rupture or the projectile may be pulled to the ground after a few yards.

d. Figure 13 shows four views, starting at the left, of the stages of pick-up of the loops by the projectile as it emerges from the barrel. The extreme right view shows the slip loop finally tightened near the base of the projectile.

e. Face the payout end of the dispenser exactly in the direction of fire.

20. Laying Wire with Rifle Grenade
(fig. 14)

The following method will allow lengths of wire up to approximately 70 yards to be payed out:

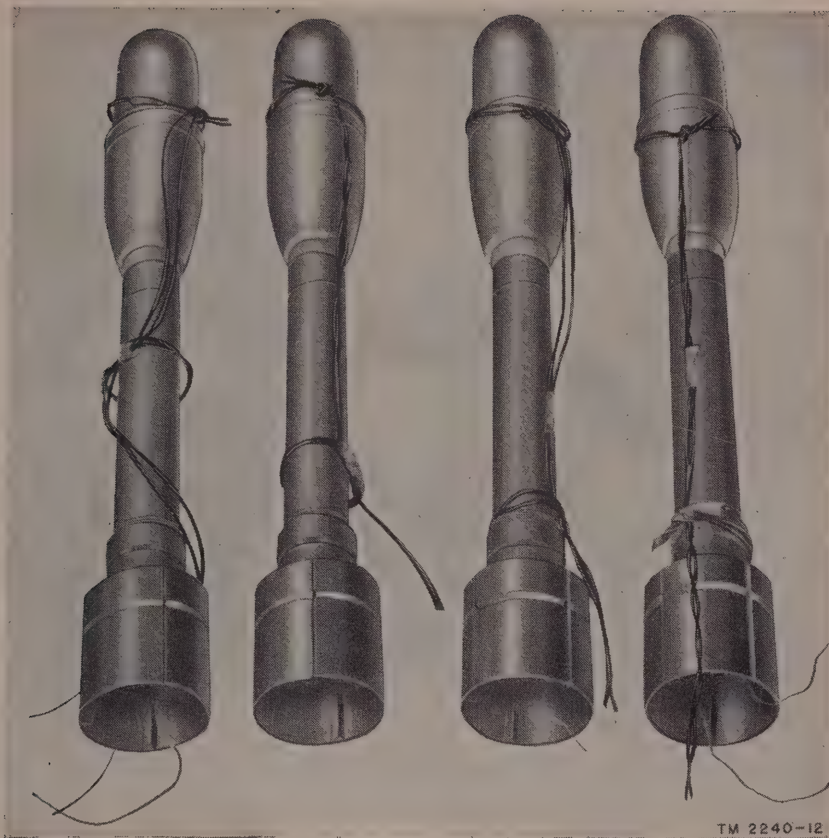


Figure 13. Four stages, from left to right of the pick-up of wire loops by a moving bazooka projectile.

a. Tie the payout end lead to the base of the grenade.

b. Pull 60 feet of wire out of the dispenser; this constitutes slack. Arrange this wire so that it extends some 30 feet in front of the dispenser and then back to the rifle. (par. 19*c*.)

c. Place the dispenser close to the firing position with the payout end facing directly in the direction of fire.

Caution: Keep clear of the wire to be payed out.

Figure 14. Using rifle grenade to lay wire.

CHAPTER 3
DEMOLITION TO PREVENT ENEMY USE

21. Methods of Demolition

a. SMASH. Use sledges, axes, handaxes, pickaxes, hammers, crowbars, and heavy tools.

b. CUT. Use axes, handaxes, or machetes.

c. BURN. Use gasoline, kerosene, oil flame throwers, or incendiary grenades.

d. EXPLODE. Use firearms, grenades, or TNT.

e. DISPOSE. Bury in slit trenches, fox holes or other holes. Throw in streams. Scatter.

f. OTHER. Use anything immediately available for destruction of this equipment.

22. Destruction of Components

When ordered by your commander, destroy all equipment to prevent its being used or salvaged by the enemy.

a. Smash (par. 21*a*) the metal wire delivery container and the improvised vehicular jig.

b. Cut (par. 21*b*) the canvas dispenser and the wiring and the canvas delivery container.

c. Burn (par. 21*c*) the canvas dispenser case, the canvas delivery container, the wire, and all instruction books.

d. Bury or scatter (par. 21*e*) any or all of the above pieces which cannot be burned.

e. DESTROY EVERYTHING.

APPENDIX
REFERENCES

Note. For availability of items listed, check SR 310–20–3 for field manuals. Check SR 310–20–4 for technical manuals and supply bulletins.

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1. Technical Manuals for Equipment Associated with Wire Dispenser MX-306A/G

TM 11–333	Telephones EE–8, EE–8–A, and EE–8–B.
TM 11–2017	Test Set TS–26/TSM.

2. Decontamination

TM 3–220	Decontamination.

3. Demolition

FM 5–25	Explosives and Demolitions.

4. Other Publications

FM 24–20	Field Wire Technique.
SB 11–47	Preparation and Submission of Requisitions for Signal Corps Supplies.
SR 310–20–3	Index of Training Publications (Field Manuals, Training Circulars, Firing Tables and Charts, Army Training Programs, Mobilization Training Programs, Graphic Training Aids, Joint Army-Navy Air Force Publications, and Combined Communications Board Publications).
SR 310–20–4	Index of Technical Manuals, Technical Regulations, Technical Bulletins, Supply Bulletins, Lubrication Orders, Modification Work Orders, Tables of Organization and Equipment, Reduction Tables, Tables of Allowances, Tables of Organization, and Tables of Equipment.
SR 700–45–5	Unsatisfactory Equipment Report (Reports Control Symbol CSGLD–247).
SR 745–45–5 NAV DEPT SERIAL 85P00 AFR 71–4	Report of Damaged or Improper Shipment (Reports Control Symbols CSGLD–66 (Army), SandA–70–6 (Navy), and AF–MC–U2 (Air Force)).

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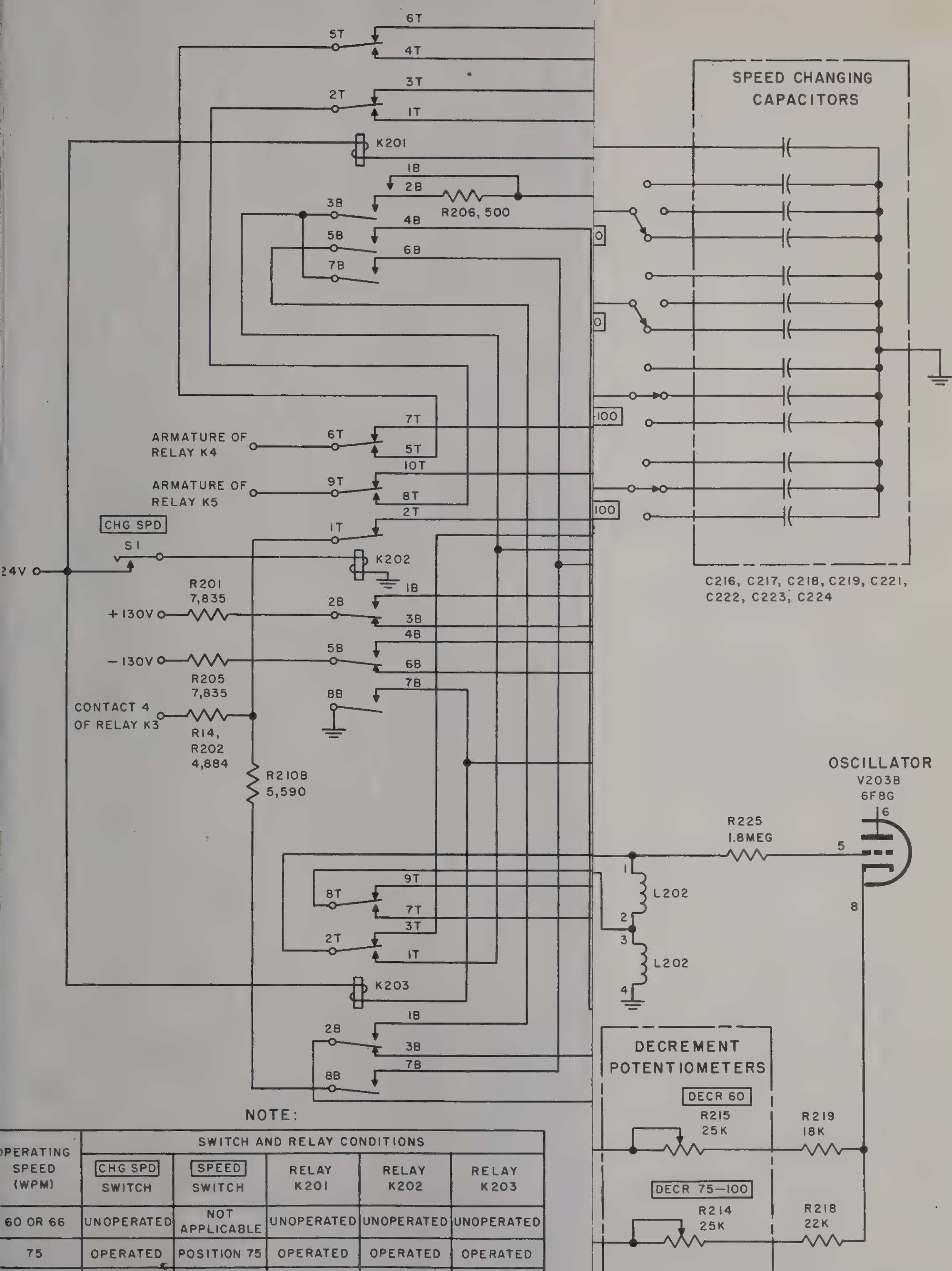
U. S. Government Printing Office, 1951—951047.



NOTE:

OPERATING SPEED (WPM)	SWITCH AND RELAY CONDITIONS				
	CHG SPD SWITCH	SPEED SWITCH	RELAY K201	RELAY K202	RELAY K203
60 OR 66	UNOPERATED	NOT APPLICABLE	UNOPERATED	UNOPERATED	UNOPERATED
75	OPERATED	POSITION 75	OPERATED	OPERATED	OPERATED
100	OPERATED	POSITION 100	UNOPERATED	OPERATED	OPERATED

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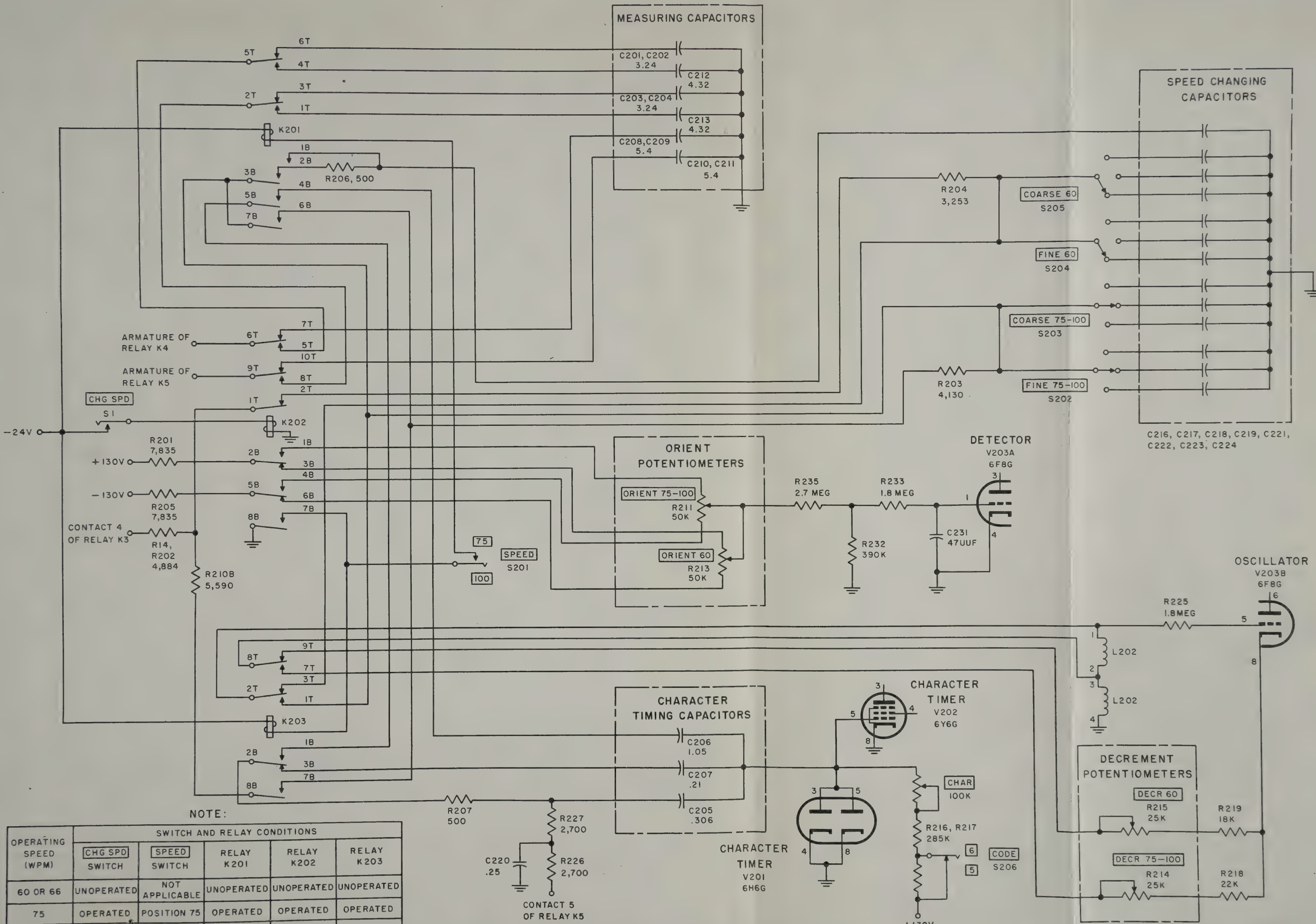


NOTE:

OPERATING SPEED (WPM)	SWITCH AND RELAY CONDITIONS				
	CHG SPD SWITCH	SPEED SWITCH	RELAY K201	RELAY K202	RELAY K203
60 OR 66	UNOPERATED	NOT APPLICABLE	UNOPERATED	UNOPERATED	UNOPERATED
75	OPERATED	POSITION 75	OPERATED	OPERATED	OPERATED
100	OPERATED	POSITION 100	UNOPERATED	OPERATED	OPERATED

Figure 29. Speed-changing circuit, simplified schematic diagram.

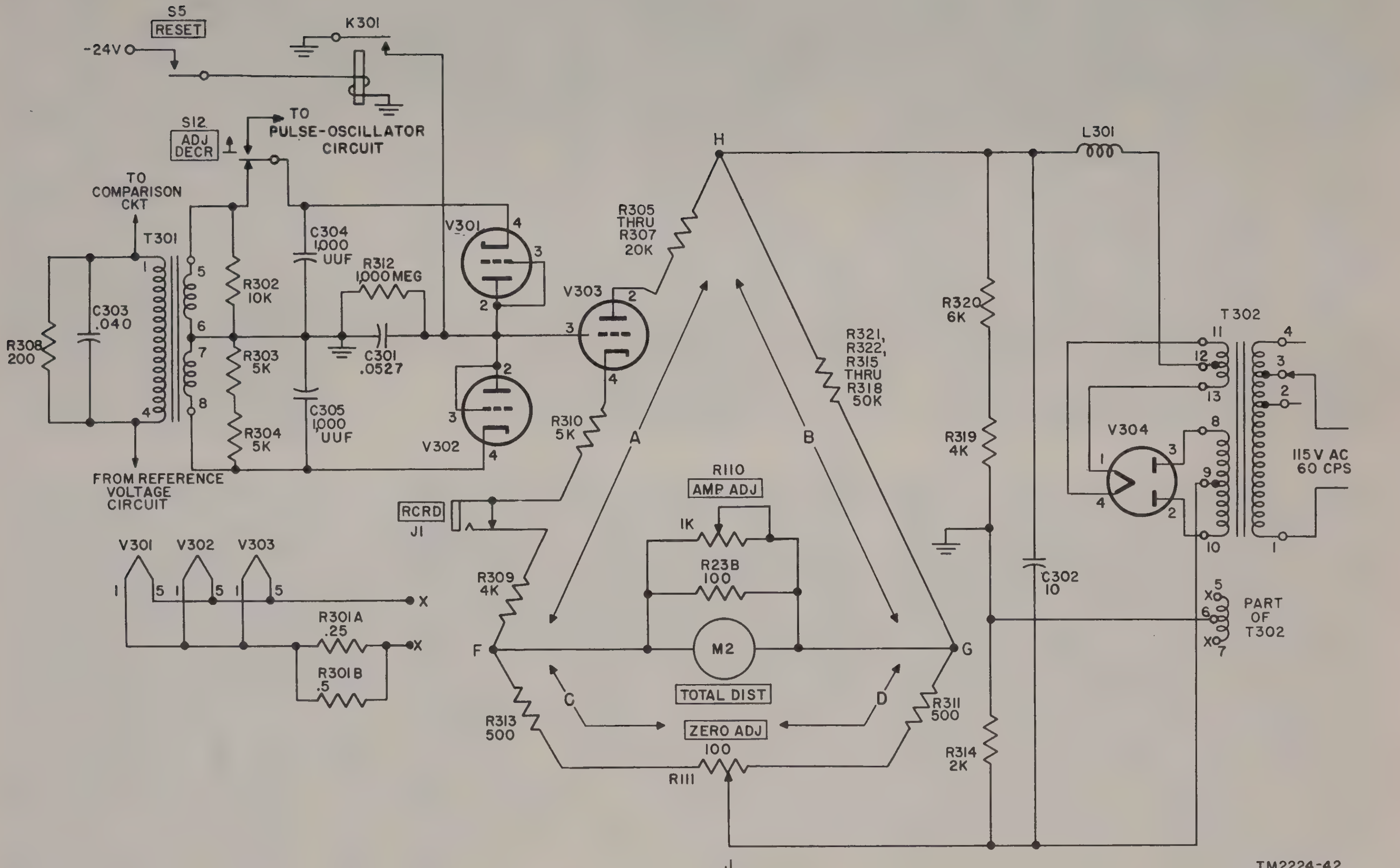


Figure 30. Rectifying peak voltmeter circuit, simplified schematic diagram.

placed on the right side of capacitor C301. This discharges any potential that may exist on capacitor C301 and places the grid of tube V303 at ground potential. When the bridge is balanced, point F is at the same potential as point G and no current can flow through the TOTAL DIST meter.

e. Tube V303 is part of a series circuit (arms A and C) that is in parallel with capacitor C302 of the power supply. The potential across capacitor C302 is 250 volts dc and its polarity is such that the potential applied to the plate of tube V303 is positive with respect to the potential applied to the cathode. The grid of tube V303 is normally at ground potential, and the potential on the cathode is approximately +4 volts. Although the grid is slightly negative with respect to the cathode, tube V303 will conduct and act as resistance in arm A of the Wheatstone bridge.

f. If a negative potential is applied to the grid of tube V303, its plate-to-cathode resistance increases and causes the total resistance in arm A of the Wheatstone bridge to increase. When this happens, the bridge is unbalanced and point F is more negative than point G. Current then flows through the TOTAL DIST meter and its protective resistors R110 and R23B, causing a deflection of the meter needle.

g. A negative potential will be applied to the grid of tube V303 *only* if a voltage is developed across capacitor C301 and this voltage will be developed *only* if current passes through winding 1–4 of transformer T301. Paragraph 87 explains the conditions necessary for current flow in transformer T301 and also why a positive potential is never applied to the grid of tube V303.

87. Signal Rectifier Circuit
(fig. 30)

Each time a transition occurs in a teletypewriter character, a voltage is developed across measuring capacitors in the comparison circuit (par. 56). The magnitude of the voltage developed across the capacitors is directly proportional to the time required for one complete transition (mark-to-space or space-to-mark). At the end of each transition, the voltage on the measuring capacitors is compared with a reference voltage. If these voltages are unequal (as is the case when distortion is present), current flows through winding 1–4 of transformer T301, which is connected in a circuit between the measuring capacitors and the reference voltage supply (fig. 26). The direction of current flow through winding 1–4 depends upon the magnitude of each of the voltages. The signal rectifier circuit converts the current in winding 1–4 (regardless of direction of flow) into a negative potential which is applied to the grid of tube V303 in the Wheatstone bridge circuit. Paragraph 86 explains how a varying negative potential on the grid of tube V303 can cause a meter indication on the TOTAL DIST meter.

a. When no current is flowing in winding 1–4 of transformer T301, the following conditions exist:

(1) The grid of tube V303 is at ground potential; however, the tube conducts because of the potentials applied to its plate and cathode by the power supply (par. 86*e*).

(2) All elements of tubes V301 and V302 are at ground potential; therefore, these tubes cannot conduct.

b. If current flows through winding 1–4 of transformer T301 and induces a voltage in winding 5–8 so that the potential on terminal 5 of transformer T301 is positive with respect to that on terminal 8, the following conditions exist:

(1) The cathode of tube V301 is positive with respect to its plate and this tube cannot conduct.

(2) The plate of tube V302 is positive with respect to its cathode and this tube can conduct. When tube V302 conducts, a negative potential is applied to the grid of tube V303 because of the voltage developed across capacitor C301.

c. If current flows through winding 1–4 of transformer T301 and induces a voltage in winding 5–8 so that the potential on terminal 5 of transformer T301 is negative with respect to that on terminal 8, the following conditions exist:

(1) The cathode of tube V302 is positive with respect to its plate and this tube cannot conduct.

(2) The plate of tube V301 is positive with respect to its cathode and this tube can conduct. When tube V301 conducts, a negative potential is ap-

plied to the grid of tube V303 because of the voltage developed across capacitor C301.

d. In either case (*b* or *c* above), the potential applied to the grid of tube V303 is always negative. Because this is true, current in the TOTAL DIST meter can only flow in one direction. For this reason, the meter needle of the TOTAL DIST meter can only deflect in one direction, regardless of the type of distortion in the teletypewriter circuit under test.

e. While the potential applied to the grid of tube V303 is always negative, the magnitude of this potential is directly proportional to the amount of distortion present in the teletypewriter circuit under test; therefore, the magnitude of deflection on the TOTAL DIST meter is also proportional to this distortion.

f. Resistor R312 provides a discharge path for capacitor C301. The value of resistance is selected so that capacitor C301 will discharge *slowly,* thus maintaining a high negative potential on the grid of tube V303 for a short time after tube V301 or tube V302 stops conducting. As a result of this condition, maximum distortion only is indicated on the TOTAL DIST meter.

g. Resistors R302, R303, R304, and R308, with capacitors C303, C304, and C305, tune the windings of transformer T301 so that no distortion is added to the varying currents passing through winding 1–4.

h. The ADJ DECR switch connects the pulse oscillator circuit to the signal rectifier circuit when preliminary operating adjustments are made on the teletypewriter test set.

Section VIII. POWER SUPPLY CIRCUIT

88. General

The power supply circuit is the source of a constant current and two constant voltages (fig. 23). One voltage is designated as the stop-compensating voltage and the other as the reference voltage. The constant current and both constant voltages are necessary for proper operation of the measuring circuit (par. 64). The circuitry of the power supply is divided into four parts to simplify presentation of the theory. The parts are designated as follows:

a. Input power circuit.
b. Constant-current circuit.
c. Stop-compensating voltage circuit.
d. Reference voltage circuit.

89. Input Power Circuit
(fig. 31)

a. Input power for the power supply circuit is obtained from a 115-volt, 60-cps source and is connected to the primary winding of transformer T101 between terminals 1 and either 2, 3, or 4. When the teletypewriter test set is installed initially, the terminals on the transformer are connected to correspond with the line voltage available and should not require further change unless the magnitude of the line voltage changes. Any connection changes made to the terminals of the primary winding will change the magnitude of the voltage appearing in the secondary windings.

b. Winding 11–13 of transformer T101 is the source of filament voltage for tube V102. The filament circuit of tube V102 is grounded.

c. Winding 8–10 is the source of plate voltage for tube V102. This tube functions as a full-wave rectifier.

d. Capacitor C101 and inductor L101 filter the dc output of tube V102.

90. Constant-Current Circuit
(fig. 31)

a. The constant-current circuit consists of tubes V101, V103, and V105 and resistors R104, R105, and R114 (constant-current potentiometer). The characteristics of tube V105 are such that its plate current is constant over a wide range of plate voltages, if the grid bias is maintained at a fixed value and if the screen supply voltage is maintained at a constant potential with respect to the cathode potential.

b. A negative 250-volt potential from capacitor C101 of the input power circuit is connected to the grid (terminal 4) of tube V105. The potential applied to the cathode (terminal 5) of tube V105 depends upon the magnitude of the current that flows through resistors R104A, R104B, and R114. The grid is negative with respect to the cathode because of the bias voltage developed across these resistors. The magnitude of the current that flows through tube V105 can be controlled by adjust-

ing the CONST CUR potentiometer. If the resistance of resistor R114 (CONST CUR potentiometer) is varied, the bias potential and the current flowing through tube V105 also vary. Once the position of the CONST CUR potentiometer is fixed, the magnitude of the current that flows through tube V105 remains constant.

(1) If the magnitude of the plate current in tube V105 tends to increase, the voltage across resistors R104A, R104B, and R114 will increase. When this happens, the bias applied to the grid of tube V105 increases and less current flows through the tube.

(2) If the magnitude of the plate current in tube V105 tends to decrease, the voltage developed across resistors R104A, R104B, and R114 will decrease. When this happens, the bias applied to the grid of tube V105 decreases and more current flows through the tube.

(3) As a result of this circuit arrangement, the magnitude of the *voltage* developed across the measuring capacitors in the comparison circuit, during charging intervals, is made proportional to the time required for each transition.

c. The screen grid of tube V105 is maintained at a constant potential with respect to the potential on the cathode to stabilize further the magnitude of the current that flows through the tube. This added stabilization is provided by the voltage-regulator circuit, which is connected to the dc output (capacitor C101) of the input power circuit. The regulator circuit consists of resistors R104A and R105 and regulator tubes V101 and V103.

(1) If the voltage across the regulator circuit tends to increase, more current flows through tubes V101 and V103 and the voltage developed across resistors R104A and R105 increases; however, the voltage across the two series regulator tubes remains constant because, as the current flow increases, the internal impedance of the tubes decrease proportionately.

(2) If the voltage across the regulator circuit tends to decrease, less current flows through tubes V101 and V103 and the voltage developed across resistors R104A and R105 decreases; however, the voltage across the two series regulator tubes remains constant because, as the current flow decreases, the internal impedance of the tubes increase proportionately.

(3) The grid of tube V105 is connected to terminal 5 of tube V101. The cathode of tube V105 is connected to terminal 2 of tube V103, through resistors R104B and R114. The voltage between terminal 5 of tube V101 and terminal 2 of tube V103 is constant, thus, the potential between the screen grid and the cathode of tube V105 is also constant.

91. Stop-Compensating Voltage Circuit (fig. 31)

The stop-compensating voltage circuit consists of resistors R101, R102, R103, and R113 (SC VOLT potentiometer), and regulator tube V104. Resistor R102 and regulator tube V104 are connected in series across the dc output (capacitor C101) of the input power circuit to form a voltage-divider circuit. If the voltage across the voltage-divider circuit varies, the voltage across resistor R102 also varies but the voltage across regulator tube V104 remains constant. For this reason, the voltage across resistors R101, R103, and R113 which are connected in parallel with regulator tube V104, is also constant. Resistors R101, R103, and R113 form a voltage-divider circuit and the stop-compensating voltage (—55 volts) is obtained by adjustment of the SC VOLT potentiometer.

92. Reference Voltage Circuit (fig. 31)

a. The reference voltage circuit consists of resistors R24 and R106, tube V106, and capacitor C102. This circuit is connected across dc output of the —130-volt power supply circuit so as not to overload tube V102. The potential on the control grid of tube V106 is obtained from the voltage-divider circuit that consists of resistors R107, R108, and R112 (REF VOLT potentiometer), which are connected in parallel with regulator tube V104. The potential applied to the grid of tube V106 is constant because of the voltage-regulating effect of tube V104.

b. Any variation in the dc output voltage of the —130-volt power supply will change the

potential applied to the cathode of tube V106, the bias of the tube, and also the magnitude of current that flows through the tube. Resistor R106 is in series with tube V106, thus, the voltage developed across resistor R106 will change to maintain the reference voltage constant.

c. Capacitor C102 is connected between the plate and the cathode of tube V106 to provide a low-impedance source for the reference voltage. Resistor R24 is used as a load resistor for the reference voltage circuit when the SC–REF VOLT meter is not connected across its output.

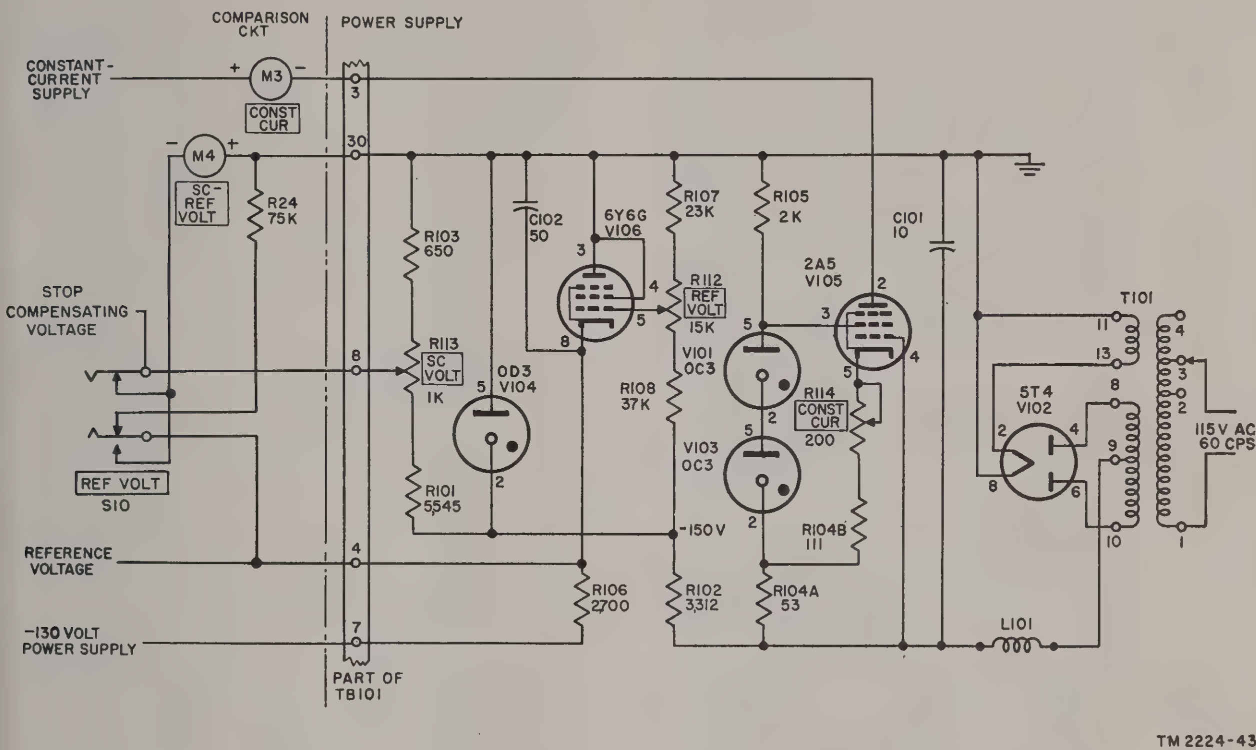


Figure 31. Power supply circuit, simplified schematic diagram.

Section IX. EXTENSION-UNIT CIRCUITS

93. General

Signals from teletypewriter circuits under test can be patched directly to the receiving relay circuits of the teletypewriter test set or they can be patched to an extension unit (fig. 23). The operation of the teletypewriter test set is similar in either case (par. 68) ; however, additional supervisory circuitry is necessary when extension units are used.

a. Automatic lockout circuits are provided to prevent simultaneous use of the measuring circuit from more than one test position at any one time.

b. Control circuits are provided so the operator at an extension-unit test position can rearrange the circuitry at the teletypewriter test set each time a different type of teletypewriter circuit operation is tested.

c. Meter circuits are provided so an operator can obtain distortion measurements at any extension-unit test position.

d. Supervisory lamp circuits are provided so an operator at any extension-unit test position can determine whether or not the teletypewriter test set is being used from any other position.

Note. The teletypewriter test set and the extension units are factory wired for use with optional ground-interrupter relay equipment. If ground-interrupter relay equipment is installed in the teletypewriter test set (par. 22), supervisory lamp circuit functions are increased.

94. Lockout Circuits
(figs. 32 and 33)

The lockout circuits prevent the use of the measuring circuit in the teletypewriter test set from more than one test position at any one time.

a. If the measuring circuit of the teletypewriter test set is idle and the plug of a patch cord is inserted into the TMS IN jack at the teletypewriter test set, two things happen:

(1) Relay K11 operates. The circuit that causes relay K11 to operate can be traced from ground at the TMS IN jack of the teletypewriter test set (fig. 32), through the closed contacts of jack J2, through the winding of relay K11, through normally closed contacts 10B and 9B of even-numbered relays K16 through K44, to a negative battery. When relay K11 operates, a circuit is completed from the tip and sleeve contacts of jack J2 to the winding of relay K2 (fig. 33). When the plug on the other end of the patch cord is inserted into the test jack of an operating teletypewriter circuit, the distortion on that circuit will be indicated on the meters of the teletypewriter test set (pars. 68–71).

(2) Ground is removed from a contact on the TMS IN jack at each extension unit (fig. 32). As a result, even-numbered relays K16 through K44 cannot operate if an attempt is made to test an operating teletypewriter circuit from an extension unit. If the even-numbered relay associated with an extension unit cannot operate, a circuit cannot be completed from the tip and sleeve contacts of the TMS IN jack, at that extension unit, to relay K2 in the teletypewriter test set (fig. 33). As a result, distortion measurements cannot be made on operating teletypewriter circuits that are connected to extension units until the plug is removed from the TMS IN jack at the teletypewriter test set.

b. If the measuring circuit of the teletypewriter test set is idle and the plug end of a patch cord is inserted into the TMS IN jack at extension unit 2, relay K18 operates (fig. 32). The circuit that causes relay K18 to operate can be traced from ground at the TMS IN jack of the teletypewriter test set, through the normally closed contacts of the TMS IN jack at extension unit 1, through the closed contacts of the TMS IN jack at extension unit 2, through the closed contacts of the READ switch at extension unit 2 (READ switch must be operated to test a teletypewriter circuit from an extension unit), through the winding of relay K18, through open contacts 10B and 9B of even-numbered relays K20 through K44, to a negative battery.

(1) When relay K18 operates, contacts 6B and 7B close and complete a circuit for the operation of relay K19. When relay K19 operates, contacts 1B and 2B close and complete a locking-ground circuit for relay K18; therefore, relay K18 will remain operated until the READ switch at extension unit 2 is released. If the plug of a patch cord is inserted into the TMS IN jack at extension unit 1 and the READ switch is operated, or if the plug of a patch cord is inserted into the TMS IN jack at the teletypewriter test set, an open in the series ground circuit at either TMS IN jack cannot cause relay K18 to release.

(2) Operation of relay K18 also prevents operation of relay K16 (associated with the TMS IN jack at extension unit 1) and relay K11 (associated with the TMS IN jack at the teletypewriter test set) because negative battery is removed when contacts 9B and 10B are open. If the plug of a patch cord is inserted into a TMS IN jack at a higher numbered extension unit, the even-numbered relays (K20 through K44) associated with that extension unit cannot operate because ground is removed at the open contacts of the operated READ switch at extension unit 2.

c. When the measuring circuit of the teletypewriter test set is being used from any test position, the tip and sleeve contacts of the TMS IN jack at every other test position is shorted. For example, if a patch cord plug is inserted into the TMS IN jack at the teletypewriter test set, the even-numbered relays (K16 through

K44) cannot operate (*b* above). The short can be traced from the tip contact to the sleeve contact of the TMS IN jack, at each extension unit through its associated even-numbered relay. Therefore, if a second teletypewriter circuit is patched to the TMS IN jack of any extension unit, it will receive no interference from the teletypewriter circuit already under test.

d. Assume that the measuring circuit of the teletypewriter test set is connected to a teletypewriter circuit that is patched to the TMS IN jack at the teletypewriter test set. Assume also that a patch cord from a second teletypewriter circuit is plugged into the TMS IN jack at extension unit 1. When the patch cord plug is removed from the TMS IN jack at the teletypewriter test set, ground is connected to a contact of the TMS IN jack at extension unit 1. When the READ switch of the extension unit is operated, a circuit is completed for the operation of relay K16 (fig. 33). When relay K16 operates, contacts 2T and 2B close to contacts 1T and 1B before contacts 3T and 3B break away from contacts 1T and 1B (fig. 71) ; therefore, the teletypewriter circuit remains closed through contacts 1T and 3T and also through contacts 1B and 3B of relay K10. When contact 9B of relay K16 closes to contact 8B, a circuit is completed for the operation of relay K10. Contacts 5T and 6T and contacts 5B and 6B of relay K10 open before contacts 1T and 2T and contacts 1B and 2B close, because contacts 5B and 5T must break away from contacts 6T and 6B before contacts 2T and 2B can be actuated; therefore, negative battery and ground are removed from winding 3–6 of relay K2 before the winding is connected to the teletypewriter circuit. Contacts 2T and 2B of relay K10 close to contacts 1T and 1B, thus connecting winding 3–6 of relay K2 to the teletypewriter circuit under test and contacts 1T and 1B and contacts 3T and 3B of relay K10 break, removing the remaining shunt from the circuit under test. This places winding 3–6 of relay K2 in series with the teletypewriter circuit under test without ever opening the loop and causing interference with its operation.

95. Controls and Meters

a. The extension unit is equipped with controls and meters that also appear on the teletypewriter test set. These controls and meters on the extension unit permit testing of teletypewriter circuits at remote locations. The SPD 75/100 switch, READ switch, RESET switch, POL–.060A–.020A switch, BIAS meter, and TOTAL DIST meter appear on the extension unit. Circuits for the controls and meters are explained in *b* through *g* below.

b. The SPD 75/100 switch is used to adjust the teletypewriter test set for use at speeds of 75 to 100 wpm. The outer contacts of the switch are connected to negative battery (fig. 33). When the switch is in its nonoperated position, the battery circuit is open. When the switch is in its operated position, negative battery is connected through the switch contacts, through operated contacts 4B and 5B of any even-numbered relay K16 through K44, inclusive (depending on the extension unit being used), through the winding of relay K202, to ground. Operation of relay K202 will connect the proper measuring capacitors in the speed-changing circuit (pars. 80–83).

c. The READ switch is operated to connect the circuit under test to the receiving relays of the teletypewriter test set. Assume that a plug is inserted into the TMS IN jack of extension unit 2 (fig. 32). The ground from the TMS IN jack of the teletypewriter test set is connected through the normal contacts of the TMS IN jack on extension unit 1, through the operated contacts of the TMS IN jack of extension unit 2, through the operated contacts of the READ switch, through the windings of relay K18, through the 9B and 10B contacts of relays K20 through K44, to negative battery at the last relay. When relay K10 operates, the circuit under test will be connected to the receiving relay circuit of the teletypewriter test set.

d. The RESET switch is operated to restore the TOTAL DIST meter indication to zero. If the RESET switch at the first extension (fig. 33) is operated, negative battery is connected through the operated contacts of the switch, through operated contacts 11B and 12B of relay K16, through the normal contacts of the RCRD jack, through the windings of relay K301, to ground. Operation of relay K301 will reset the TOTAL DIST meter indication rapidly. If the RCRD jack is being used at the teletypewriter test set, its normally closed contacts will be open and operation of the RESET switch at an extension unit will not restore the TOTAL DIST meter indication to zero.

e. The POL–.060A–.020A switch is used to

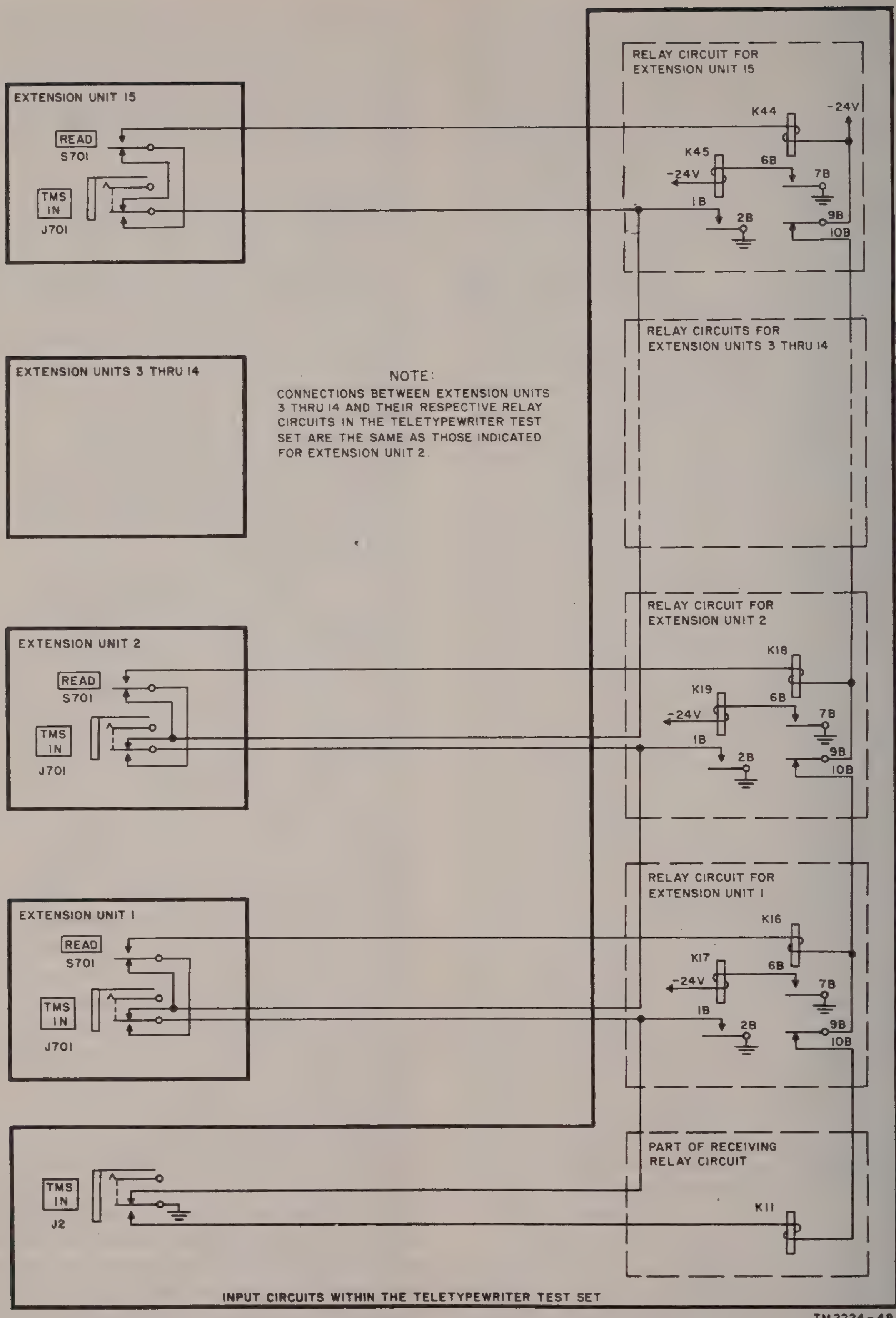
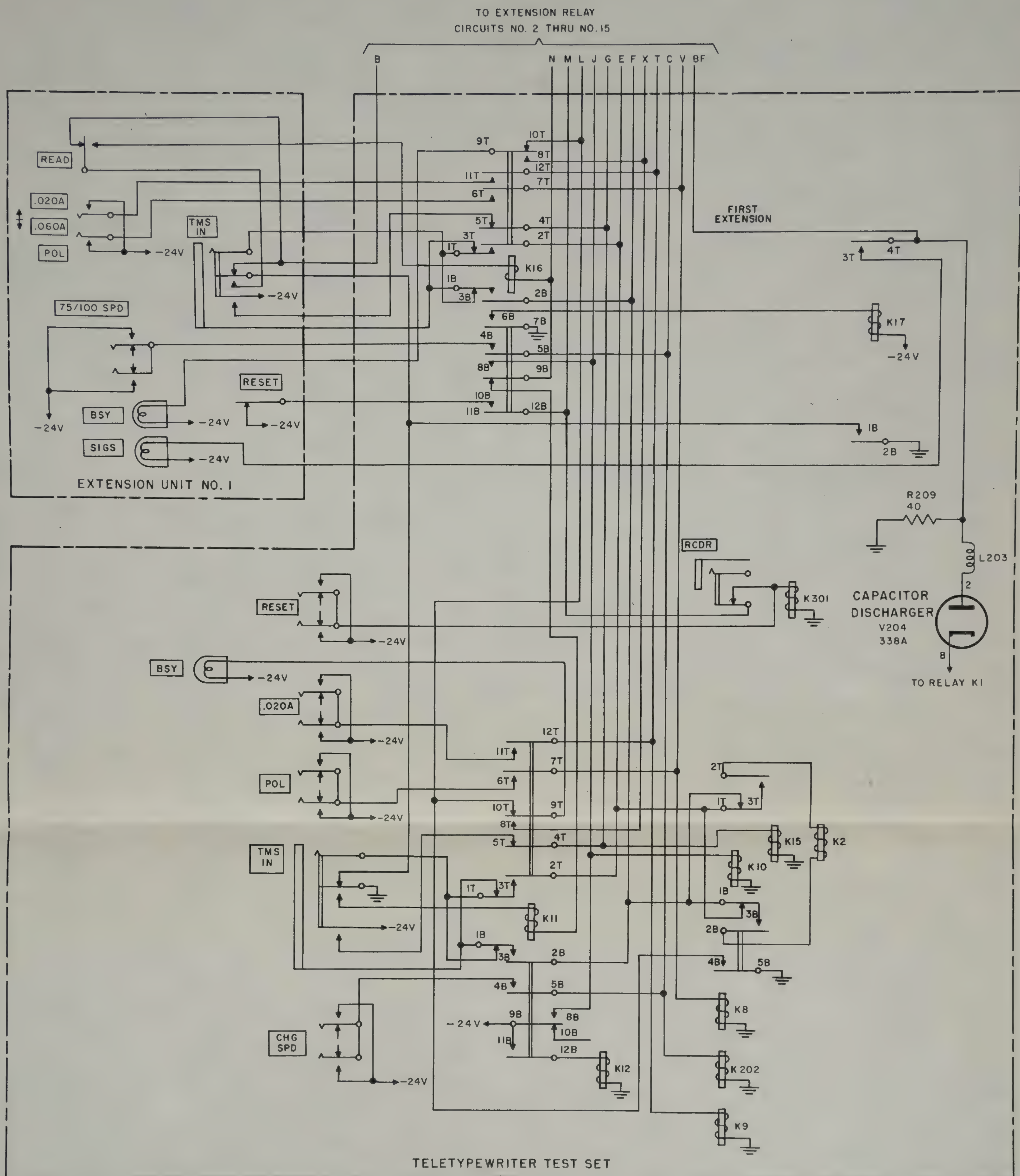


Figure 32. Lockout circuit, block schematic diagram.



NOTE:
FOR CONNECTIONS TO OTHER CIRCUITS, REFER TO OVERALL AND INTERCONNECTION DIAGRAMS.

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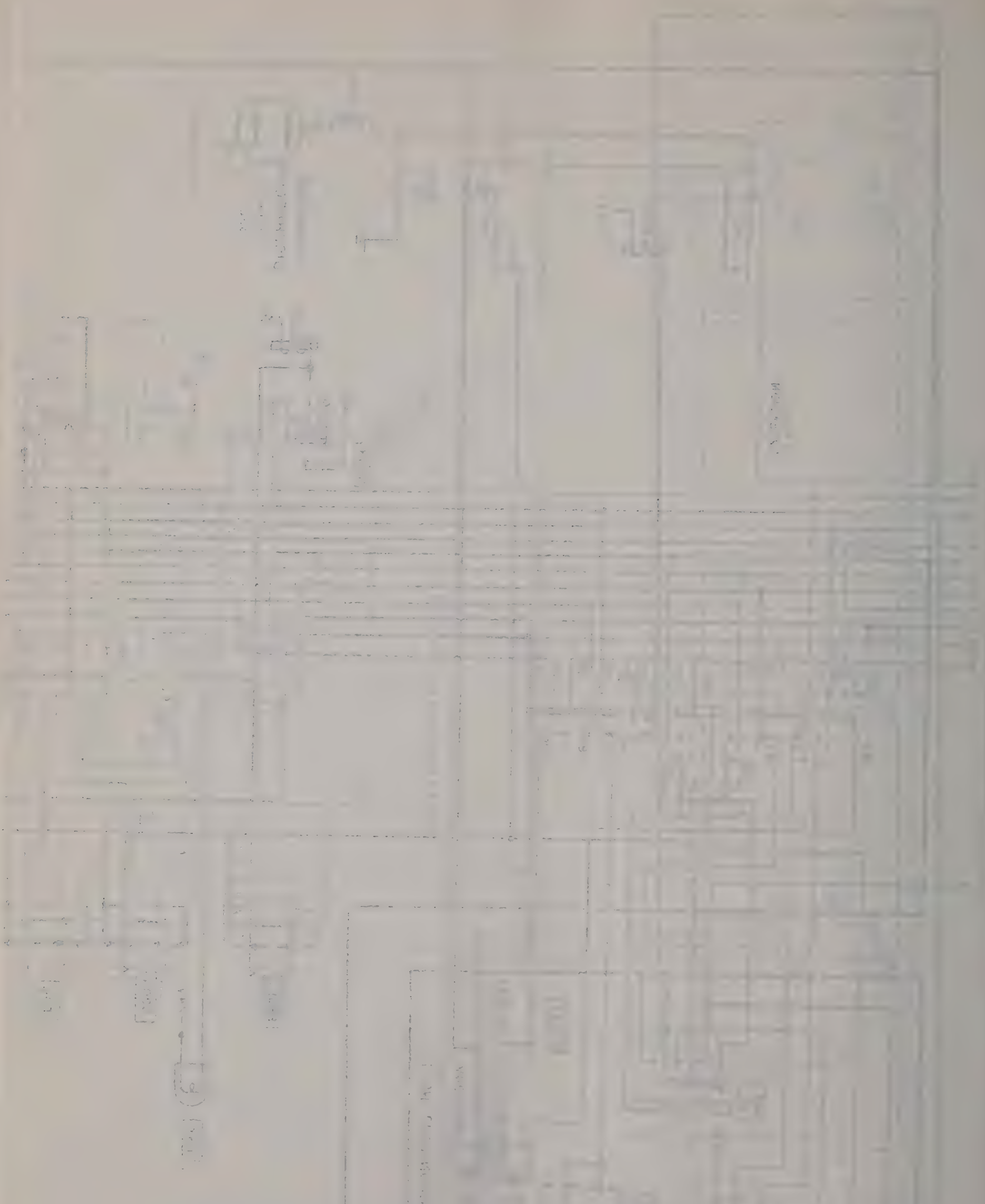
Figure 33. Extension-unit circuit, simplified schematic diagram.



arrange the wiring of the teletypewriter test set for either polar operation or 20 ma or 60 ma neutral operation (fig. 33).

(1) When the switch is operated to the .020A position at the first extension unit (fig. 33), negative battery is connected from the contacts of the switch through contacts 11T and 12T of relay K16, through the windings of relay K9, to ground. The effect of operating relay K9 is described in paragraph 70.

(2) When the switch is operated to the POL position at the first extension unit (fig. 33), battery is connected from the contacts of the switch through contacts 6T and 7T of relay K16, through the windings of relay K8, to ground. The effect of operating relay K8 is described in paragraph 71.

(3) Operation of the POL–.060A–.020A switch from the second extension unit or any other extension unit up to (and including) the last extension unit is similar to that in (1) and (2) above.

f. The BIAS meters of all extension units and the teletypewriter test set are connected in series (fig. 7). Meter indications for a circuit under test at any position will appear on the BIAS meters at all other test positions.

g. The TOTAL DIST meters of all extension units and the test set are connected in series (fig. 7). Meter indications for a circuit under test at any test position will appear on the TOTAL DIST meters at all other test positions.

96. SIGS Lamp

When the teletypewriter test set is being used to test a teletypewriter circuit at an extension unit, the SIGS lamp at the extension unit flashes irregularly to indicate that a teletypewriter signal is present on the circuit under test. The irregular flashing of the SIGS lamp will be present at the extension unit even if the teletypewriter signal being tested at that position is so free of distortion that there is no indication on either the BIAS or TOTAL DIST meter.

a. When teletypewriter signals are connected to the teletypewriter test set from an extension unit, the measuring capacitors are discharged at the middle of each character element (par. 79). When tube V204 fires, current flows through inductor L203 and resistor R209. A voltage is developed across R209 and is applied to the SIGS lamp at the extension unit (figs. 26 and 34).

b. The potential developed across resistor R209 is applied through closed contacts 3T and 4T of an odd-numbered relay, K17 through K45 (depending upon which extension is being used) to the SIGS lamp, which is connected to ground. The SIGS lamp, therefore, flashes whenever a measuring capacitor is discharged even if there is no distortion present in the teletypewriter signal.

97. BSY Lamp
(fig. 35)

In this paragraph, explanations of the BSY lamp supervisory circuits are based on the assumption that optional ground-interrupter relay equipment is connected to the teletypewriter test set as described in paragraph 22. If ground-interrupter equipment is not connected to the teletypewriter test set, explanations of BSY lamp *flashing signals* (either 60 or 120 times each minute) do not apply.

a. General.

(1) If the teletypewriter test set is properly calibrated for the teletypewriter circuit under test, a plug inserted into the TMS IN jack of any extension unit or at the teletypewriter test set will cause the BSY lamp to light permanently at all other stations to indicate that the teletypewriter test set is being used.

(2) If the teletypewriter test set is calibrated for use with 100-wpm teletypewriter circuits or if the teletypewriter test set is calibrated for use with teletypewriter circuits using six intelligence elements for each teletypewriter character, the BSY lamp will flash 120 times each minute at any test location where a plug is inserted into a TMS IN jack.

(3) If a teletypewriter circuit is being tested at any one of the extension units or at the teletypewriter test set ((1) above), any attempt to test a second teletypewriter circuit (by inserting a plug into the TMS IN jack at some other location) will cause the

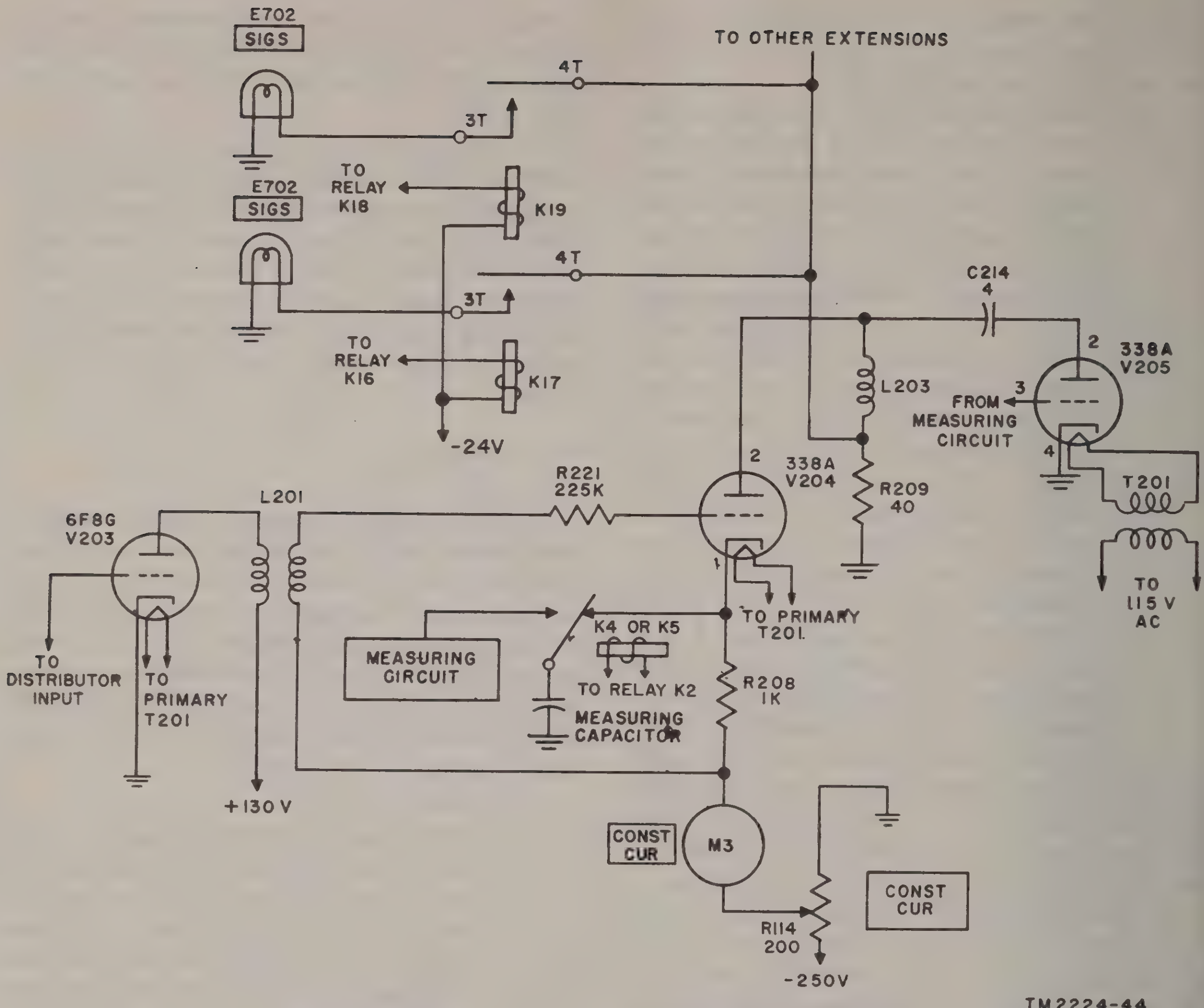


Figure 34. SIGS lamp circuit, simplified schematic diagram.

BSY lamp to flash 60 times each minute at the location where the first circuit is being tested.

b. BSY Lamp Flashing 120 Times Each Minute.

(1) If the SPEED 75–100 switch is operated to the 100 position and the CHG SPD switch is operated at the teletypewriter test set or if the SPD 75/100 switch is operated at an extension unit, relay K203 operates as soon as a plug is inserted into the TMS IN jack at any test position. If it is assumed that the plug is inserted into the TMS IN jack of the teletypewriter test set, relay K11 will also operate. A circuit is completed from battery at contacts 8B and 9B or relay K11, through the windings of relay K13, to ground. When relay K13 operates, ground from contacts 1T and 2T complete a circuit for the operation of an external 60 ipm and 120 ipm interrupter. Interrupted ground from the 120 ipm interrupter is connected through the normal contacts of the SPEED 75/100 switch (position 100) through contacts 4B and 5B relay K203, through the normal contacts of the CODE 5–6 switch (position 5), through contacts 8T and 9T of relay K11, through the BSY lamp, to battery. The BSY lamp will now flash to indicate that the teletypewriter test set is calibrated for testing 100 wpm circuits.

(2) If the teletypewriter test set is calibrated for six intelligence elements for each teletypewriter character, the CODE 6–5 switch will be operated to position 6 and the circuit for the 120 ipm signals will be completed through the operated contacts of the CODE 6–5 switch (position 6) instead of through the contacts of SPEED 75–100 switch (position 75) and BSY lamp will flash 120 times each second.

c. BSY Lamp Flashing 60 Times Each Minute.

(1) Assume that a circuit is being tested at the teletypewriter test set position. The plug inserted into the TMS IN jack at the teletypewriter test set will cause relays K11 and K10 to operate. Ground from contacts 4B and 5B of relay K10 causes the BSY lamp to light at all extension units; however, the lamp at the teletypewriter test set will not light because the test is being made at that position and open contacts 9T and 10T of relay K11 break the circuit for the BSY lamp. Assume that a plug is inserted into the TMS IN jack of the first extension unit. Relay K16 cannot operate because of the lockout feature described in paragraph 94. Battery from the operated contact of relay K16 completes a circuit to ground at relay K15 and relay K15 will operate. Ground from the 1T and 2T contacts of operated relay K13 starts the 60 ipm interrupter as described in *b* above. A 60 ipm signal is connected through contacts 1T and 2T of relay K15, through contacts 5B and 6B of unoperated relay K203, through CODE 5–6 switch (position 5), through operated contacts 8T and 9T of relay K11, through the BSY lamp, to battery. The BSY lamp at the teletypewriter test set will flash 60 times each minute to indicate that use of the teletypewriter test set is required at an extension unit.

(2) When the BSY lamp is flashing 120 times each minute to indicate that the teletypewriter test set is either calibrated for operation at 100 wpm or for use with teletypewriter signals which have six intelligence elements for each character, the 60 ipm circuit is open either at the SPEED 75–100 switch or the CODE 5–6 switch.

Section X. REGULATED TUBE RECTIFIER CIRCUIT

98. General

Two regulated tube rectifiers are located near the bottom of the teletypewriter test set. The top regulated tube rectifier furnishes +130 volts dc; the bottom regulated tube rectifier furnishes —130 volts dc. Transformers T1 in the two 130-volt regulated tube rectifiers furnish the ac for the 24-volt power supply, which is used to operate relays of the teletypewriter test set. The two 130-volt dc regulated tube rectifiers are designed to operate from either a 115- or 230-volt ac input, but the 115-volt input is used in the teletypewriter test set application. The dc output voltage of each rectifier is adjustable and the polarity is determined by internal strapping.

99. Rectification
(fig. 36)

a. The rectifier circuit employs two gas-filled, three-element tubes. Each tube conducts during alternate half-cycles, providing full-wave rectification. The ac input supply is applied to terminals 9 and 10 of terminal board A through switch SW1, through two 3-ampere fuses, to the primary windings 3–4 and 1–2 of transformer T1, which are connected in parallel for a 115-volt input. The filaments of tubes V1 and V2 receive power from windings 10–11 and 11–12 of transformer T1. The plate supply for the tubes is supplied from windings 6–7–8 of transformer T1. In figure 36, terminal 7 of transformer T1 is shown grounded through inductance L1 and the strap between terminals 1 and 8 on terminal board A. Terminal 7 of terminal board B is the positive terminal of the rectifier and because the negative side of the circuit is grounded, the output of this rectifier will be positive.

b. Assume that the voltage induced in wind-

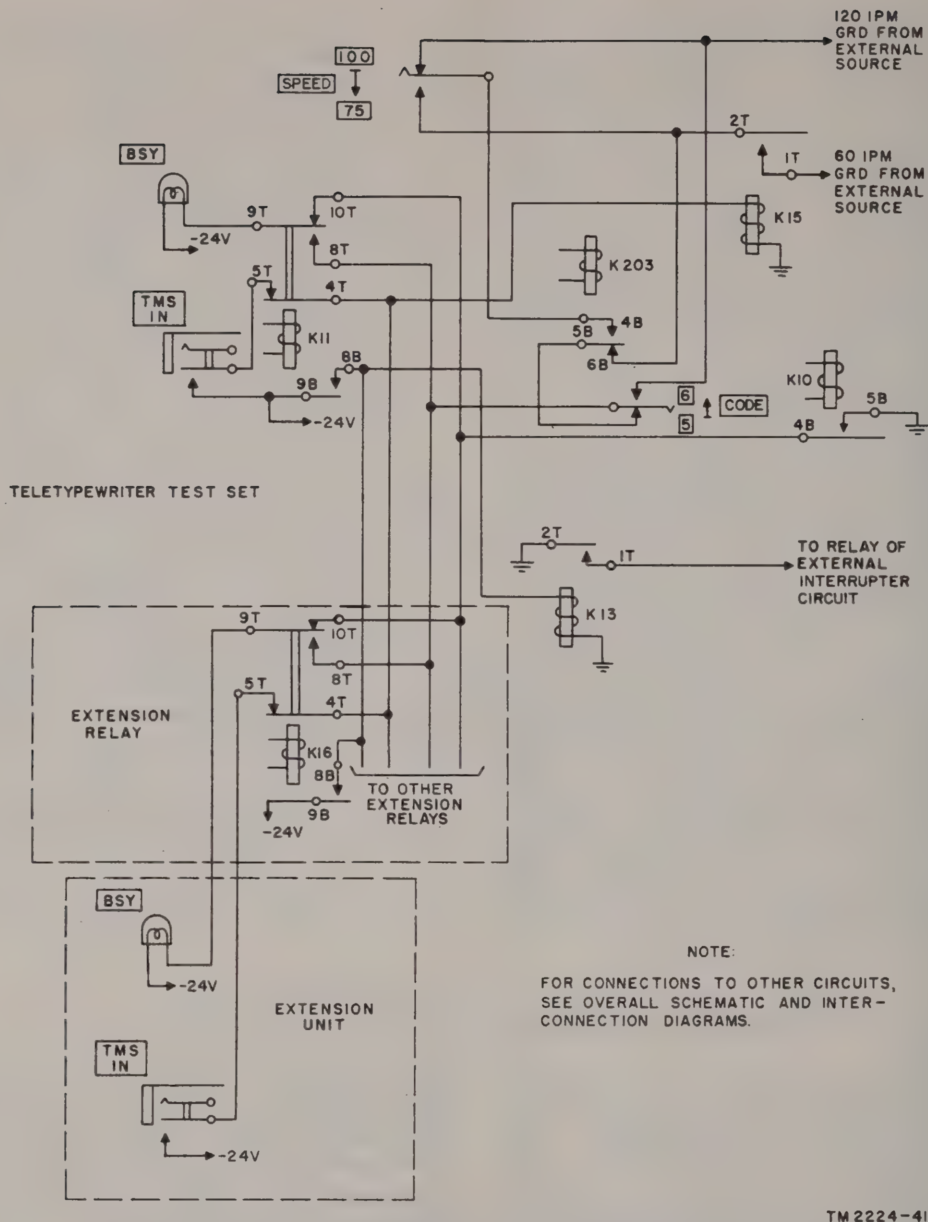


Figure 35. BSY lamp circuit, simplified schematic diagram.

ings 6–7–8 of transformer T1 is such that terminal 6 is positive and terminal 8 is negative. The plate of tube V2 is negative; therefore, tube V2 will not conduct. The plate of tube V1 is positive; therefore, tube V1 will conduct. The circuit may be traced as follows: from ground at terminal 1 on terminal board B, through the load, to terminal 7 on terminal board B, to terminal 11 of transformer T1, to terminal 2 or the filament of tube V1, to the plate of tube V1, through inductor L4, through winding 6–7 of transformer T1, through inductor L1, to terminal 1 of terminal board B, which is strapped to terminal 8 and ground, completing the circuit. On the next half-cycle of the induced voltage in winding 6–7–8 of transformer T1, terminal 8 is positive and terminal 6 is negative. The plate of tube V1 is negative; therefore, tube V1 will not conduct. The plate of tube V2 is positive; therefore, it conducts. The circuit may be traced from ground at terminal 1 on terminal board B, through the load, to terminal 11 of transformer T1, through tube V2, through inductor L3,

through winding 8–7 of transformer T1, through inductor L1, to terminal 1 of terminal board B, through a strap, to ground at terminal 8. The electron flow is in the same direction through the load, thus, full-wave rectification of the input ac is provided.

c. In the negative rectifier the same rectification as described above takes place, with the electron flow in the same direction, except that grounded terminal 8 is connected to terminal 3.

100. Filters
(fig. 36)

a. The ripple in the rectified dc is reduced by inductor L1 and capacitors C1 through C8. These parts make up the filter circuit.

b. Inductors L3 and L4 with capacitors H and H1 suppress radio-frequency (rf) noise generated in tubes V1 and V2. Capacitors D, D1, and E, together with the electrostatic shield in transformer T1, prevent transfer of carrier-frequency and rf noise (originating within the rectifier) over either the ac or dc leads.

101. Tube Operation
(fig. 36)

a. The rectifier tubes are of the gas-filled, three-element type. The point in the ac cycle at

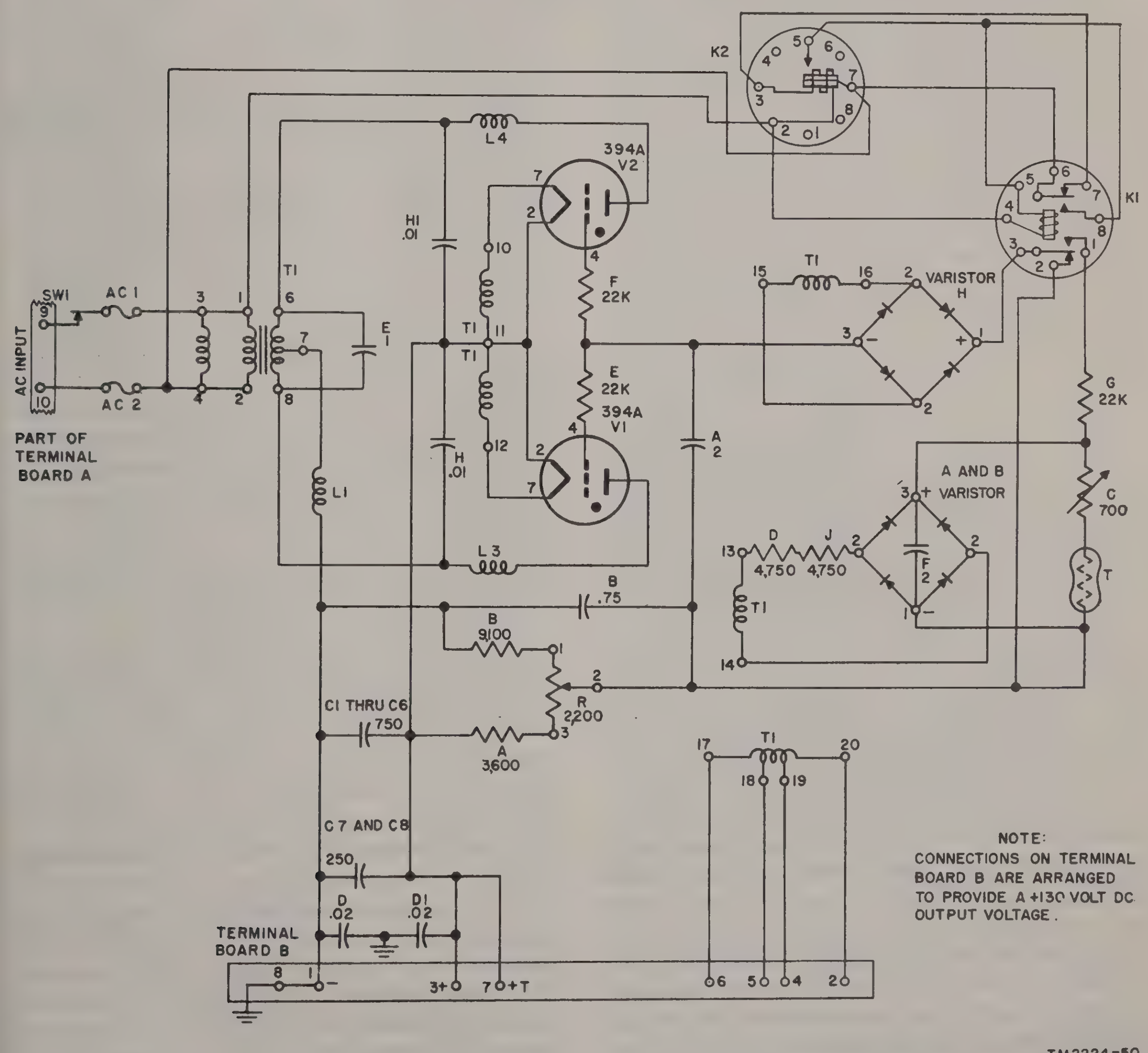


Figure 36. Regulated tube rectifier, simplified schematic diagram.

which they start firing (conducting current) is controlled by the negative grid bias (differenc between the voltage of the grid and that of the filament). In general, the greater the negative grid bias, the higher the plate voltage must be before current starts to flow, but for any tube there is a critical negative grid bias beyond which the tube will not fire. After starting to fire, the gas within the tube ionizes and conducts current vigorously. The tube continues to conduct current for the balance of the ac half-cycle. The output current (and consequently, the output voltage) depends upon the time that the tube conducts for each half-cycle. Tube V1 fires during one half-cycle and tube V2 fires during the other half-cycle. This results in full-wave rectification. Any change in the output voltage will affect the grid circuit to restore the output voltage to its predetermined regulated value.

b. At light loads, it is not necessary for the tubes to fire every cycle, because capacitors C1 through C8 carry the load for a few cycles, during which time the grid bias is sufficient to prevent firing the tubes. When the output voltage decreases below the regulated value, the tubes fire again for a few cycles to recharge the capacitors. This type of operation is evidenced by a flicker in the flow within the tubes and by vibration of the needle of an attached voltmeter. At extremely light loads, firing of one tube is enough to keep the output voltage at the regulated value. Even at heavy loads with the tubes loaded approximately equally, current flow from the tubes will not necessarily be uniform because of variation in temperature and physical characteristics of the tubes.

102. Regulation

a. The regular circuit for the dc output consists of three parts: a potentiometer (fixed resistors A and B and potentiometer R), a reference voltage circuit (par. 103), and varistor H which furnishes line voltage compensation.

b. Resistors A and B and potentiometer R are connected in series across the dc output so that the current through them is proportional to the output voltage.

c. The filaments of tube V1 or V2 are at the positive output potential (fig. 37). The grid is about 3 volts less positive than this value. The grid circuit may be traced as follows: from ground through resistor B, through the 1–2 part of potentiometer R (giving a voltage rise), through varistors A and B (which gives a rise in voltage), through resistor G, then through varistor H (which is poled opposite to the other voltages and gives a voltage drop), then to the grid of tube V1 or V2. This overall combination is approximately at +127 volts, which is 3 volts negative with respect to the +130-volt filament.

d. Potentiometer R is adjusted so that the grid voltage is just negative enough with respect to the filament to permit the tubes to fire over enough of each ac cycle to maintain the desired output dc voltage. This desired voltage is measured by placing a voltmeter across the output (par. 29) while adjusting potentiometer R. Once the output voltage has been adjusted, it will be maintained at its proper value. If the output voltage increases, the voltage at the filaments of tubes V1 and V2 correspondingly rises. Current through resistors B, R, and A increases and causes the voltage at terminal 2 of potentiometer R to increase in a positive direction. The rise in voltage at terminal 2 of potentiometer R (not as great as the rise in voltage at the filament) appears at the grid. Because the positive increase at the filament is greater than the positive increase at the grid, the grid becomes negative with respect to the filament. The greater negative bias decreases the length of the time that the tubes will fire and the output voltage returns to its regulated value. If the output voltage decreases, the filament and grid voltages drop, but the grid voltage drops a lesser amount, thus, the grid bias decreases. This will increase the length of time that the tube will fire and the output voltage will return to its regulated value.

e. Input line voltage variations are corrected by the function of varistor H. The output of the varistor is in the grid circuit and its ac input voltage is furnished by winding 15–16 of transformer T1 (fig. 35). It is poled so that its dc output voltage is opposed to the dc voltage that is furnished by resistors A, B, R and varistors A and B. If the ac line voltage decreases, the dc output voltage of varistor H is reduced and the grid voltages becomes more positive. The difference in voltage between the grid and the filaments now becomes smaller. This decrease of bias (grid becomes less negative) increases the current flow in the tubes. Increased current flow will increase the dc output voltage sufficiently to balance the decrease of dc output

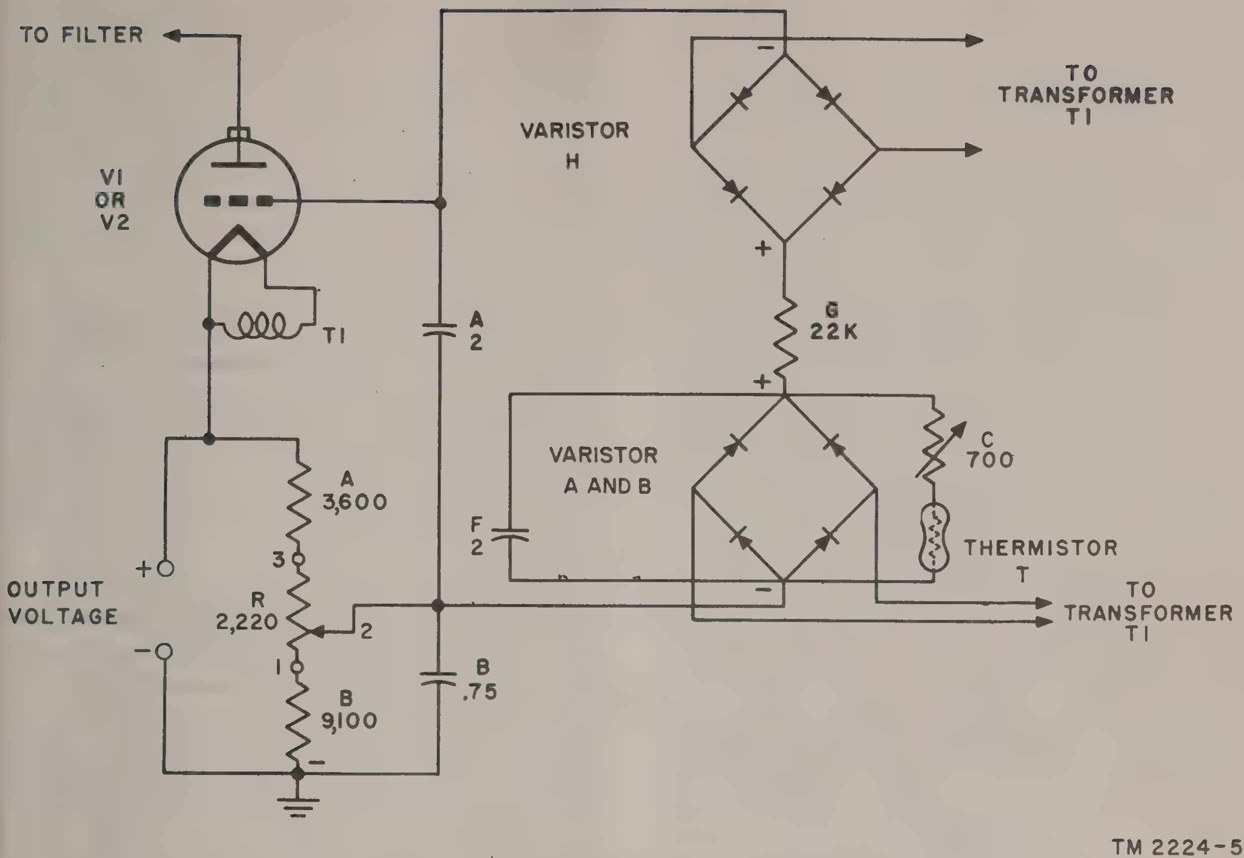


Figure 37. Grid bias, simplified schematic diagram.

voltage caused by the decrease in line voltage. For this reason, the dc output remains constant. If the ac line voltage increases, the opposite effect takes place. The dc output voltage of varistor H increases, increasing the grid bias sufficiently to reduce the dc output voltage. Capacitor B provides a bypass around the potentiometer for sudden changes of voltage and makes the grid control circuit more responsive to rapid changes in the load. Capacitor A and resistor G act as a filter to remove any ripple that may exist in the rectified dc output of varistor H.

f. The grid circuits of tubes V1 and V2 are common. Resistors E and F separate the two grids and limit the grid current.

103. Reference Voltage
(fig. 36)

a. A constant reference voltage is required for proper operation of this rectifier. This reference voltage is furnished by a circuit that consists of varistors A and B (which are connected as a full-wave rectifier), resistor C, thermistor T, and capacitor F.

b. Winding 13–14 of transformer T1 furnishes the ac input voltage. Resistors D and J are placed in series with varistors A and B to maintain the voltage developed across varistors A and B as constant as possible. If the ac line voltage increases, more current tends to flow through the series combination of resistors and varistors. The resistance of D and J is large compared to that of the varistors; therefore, a larger voltage will be developed across the resistors and the voltage developed across the varistors will be small. Conversely, when ac line voltage decreases, the voltage developed across resistors D and J tends to be reduced, thus allowing only a small voltage to develop across varistors A and B.

c. Thermistor T and resistor C are in series across varistors A and B. If the voltage developed across varistors A and B increases, a greater current will flow through resistor C and thermistor T. An increase in current through

the resistor will increase the voltage developed across it, while the voltage developed across the thermistor will decrease. (The thermistor has a negative temperature coefficient.) The overall voltage drop across the series combination of resistor C and thermistor T tends to remain constant because the two parts are selected so that the voltage increase in one is compensated for by a voltage decrease in the other. As more current flows through varistors A and B, the voltage developed across resistors D and J will increase and tend to reduce the increase in voltage developed across varistors A and B as explained in *b* above. The opposite effect takes place when the voltage developed across varistors A and B decreases. The current through resistor C and thermistor T decreases. In this case, the voltage developed across resistor C tends to decrease while the voltage developed across thermistor T tends to increase. The voltage developed across resistors D and J also decreases, tending to balance out the decrease in voltage developed across varistors A and B. Effectively, the voltage across resistor C and thermistor T is constant. Capacitor F removes the ripple in the rectified dc output voltage of varistors A and B.

104. Time-delay Relays
(fig. 36)

Two time-delay relays (K1 and K2) are provided to delay firing of tubes V1 and V2 until the filaments have heated to the proper operating temperatures. When power is first connected to the rectifier, voltage is applied to the plates of tubes V1 and V2, but no current flows because the grid of the tubes are biased beyond cutoff. This is accomplished by removing the reference voltage (furnished by varistors A and B) from the grid circuit. The grid circuit can be traced from terminal 2 of potentiometer R, through contacts 2 and 3 of relay K1 (relay K1 is not yet operated), through varistor H, through resistors E and F, to the grids of tubes V1 and V2.

a. When ac power is connected to the power supply at terminal board A, a circuit is completed from terminal 10 of terminal board A to terminal 7 of relay K2, through normal contacts 6 and 7 of relay K1 to terminal 3 of relay K2, through the heater winding of relay K2, to terminal 2 of relay K2, to terminal 9 of terminal strip A, completing the heater circuit of relay K2. As the heater winding of relay K2 warms up (because of the current flow through it), the metal armature bends, because it is made of two different metals each having a different coefficient of expansion. Twenty seconds after current has been applied to the heater winding, the armature of relay K2 bends sufficiently to close terminal 5 to terminal 7 (through the armature and contact).

b. The operating winding of relay K1 is now connected to the ac supply. The circuit can be traced from terminal 10 of terminal board A to terminal 7 of relay K2, through the operated armature to contact 5 of relay K2, to terminal 5 of relay K1, through the winding to terminal 4 of relay K1, to terminal 2 of relay K2 and back to terminal 9 of terminal board A. Relay K1 operates.

c. Contacts 6 and 7 of relay K1 open and contacts 6 and 8 close. Opening of contacts 6 and 7 opens the heater winding of relay K2 and the armature of relay K2 starts to restore. Closing of contacts 6 and 8 locks winding of relay K1 to the ac input, so that the operating current, which previously flowed from terminal 7 of relay K2 through the made contacts 7 and 5 of relay K2 to terminal 5 of relay K1, now flows from terminal 7 of relay K2, through closed contacts 6 and 8 of relay K1 to terminal 5 of relay K1.

d. Contacts 2 and 3 of relay K1 open and contacts 1 and 3 close. Opening of contacts 2 and 3 of relay K1 opens the circuit from terminal 2 of potentiometer R to varistor H and places the reference voltage circuit of varistors A and B in the grid circuit of tubes V1 and V2. The addition of the reference voltage in the grid circuit places the proper bias on the grids of tubes V1 and V2 and they fire, thus starting the conduction of current and regulation of voltage.

105. Cover Switch

When the front cover of a regulated tube rectifier is removed, cover switch SW1 opens one side of the ac line to protect maintenance personnel from the relatively high plate voltages within the rectifier. The cover switch does not remove the power supply voltage from input terminal board A. If the ac line lead connected to terminal 10 of this terminal board is the ungrounded side, ac line voltage will be present on the fuses, the AC terminal board, trans-

former T1 primary terminals, and the ac wiring to timer relays K1 and K2, even when the cover switch is operated. To avoid shocks and destructive short circuits, disconnect the ac supply before working on the power supplies unless a live circuit is necessary, as it is when making point-to-point voltage checks. An effective way to remove the ac voltage is to pull out the ac supply plug at the rear of the teletypewriter test set.

Section XI. 24-VOLT DC POWER SUPPLY AND 110-VOLT AC SUPPLY CIRCUITS

106. Dc Power Supply, 24 Volts
(fig. 38)

The ac input for the 24-volt power supply is obtained from windings of transformer T1 in both 130-volt regulated tube rectifiers (par. 98). The T1 windings are connected in series and the ac voltage appearing across these windings is applied to varistor CR610, which is arranged for full-wave rectification.

a. Assume that the polarity of the ac cycle is such that terminal 2 of transformer T1 in the +130-volt regulated tube rectifier is positive and that terminal 6 of transformer T1 in the —130-volt regulated tube rectifier is negative. Current will flow from terminal 2 of transformer T1 to terminal 2 of varistor arrangement CR601, through the varistors to terminal 3, to terminal 8 of terminal board TB601, to ground, through the load (not shown) to terminal 5 of terminal board TB601, through resistor R601, to terminal 1 of varistor arrangement CR601, through the varistors to terminal 4, to terminal 6 of transformer T1, through windings of the transformers to terminal 2 of transformer T1, completing the circuit.

b. When terminal 2 of transformer T1 in the +130-volt regulated tube rectifier becomes negative and terminal 6 of transformer T1 in the —130-volt regulated tube rectifier becomes positive, current flows from terminal 6 of transformer T1 to terminal 4 of varistor arrangement CR601, through the varistors to terminal 3, to terminal 8 of terminal board TB601, to ground, through the load to terminal 5 of terminal board TB601, through resistor R601, to terminal 1 of varistor arrangement CR601, through the varistors to terminal 2, to terminal 2 of transformer T1, through the windings of the transformers to terminal 6 of transformer T1, completing the circuit. The current always flows through the load in the same direction, giving full-wave rectification.

c. The filter circuit consists of capacitors C601 and C602 together with resistor R601. In addition to serving as part of the filter circuit, resistor R601 is adjustable so that the output voltage (under load) may be varied to maintain 24 volts and thus compensate for aging of the varistor.

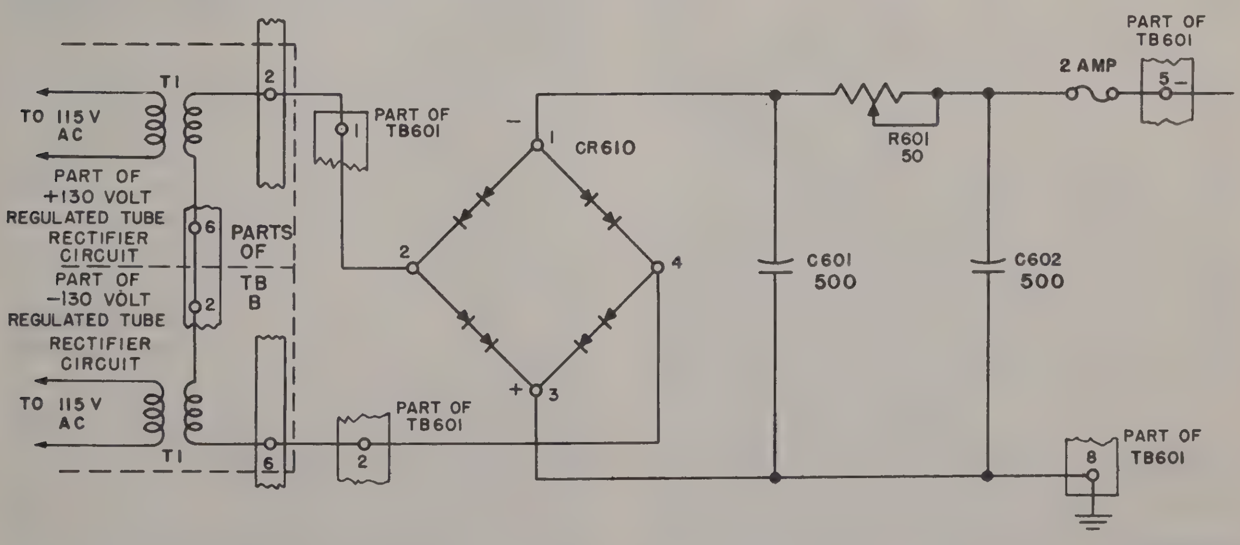


Figure 38. 24-volt dc power supply, simplified schematic diagram.

107. Ac Power Distribution Circuit (fig. 39)

The ac power distribution circuit consists of microswitch S14, power switch S13, and six outlets. Five equipment outlets are conveniently located at the rear of the teletypewriter test set (fig. 2) for use with the PWR SUP panel, the DISTRIBUTOR panel, the RECT PEAK VM panel, and the two 130-volt REG TUBE RECT panels. There is also a convenience outlet provided for use with an extension or a soldering iron. The ac power switch and the microswitch are connected in series and control the ac circuit to the five equipment outlets. Operation of either the ac power switch or the microswitch will not control the ac voltage which appears at the convenience outlet. The ac power switch is located on the front of the teletypewriter test set (fig. 1) and is used to turn off all power to the teletypewriter test set equipment outlets. The ac power switch also opens the ground circuit for relay K6. The microswitch is connected to the rear door and opens the ac power distribution circuit to the equipment outlets when the door is open. This feature is provided to protect personnel who may have to work on circuits within the teletypewriter test set.

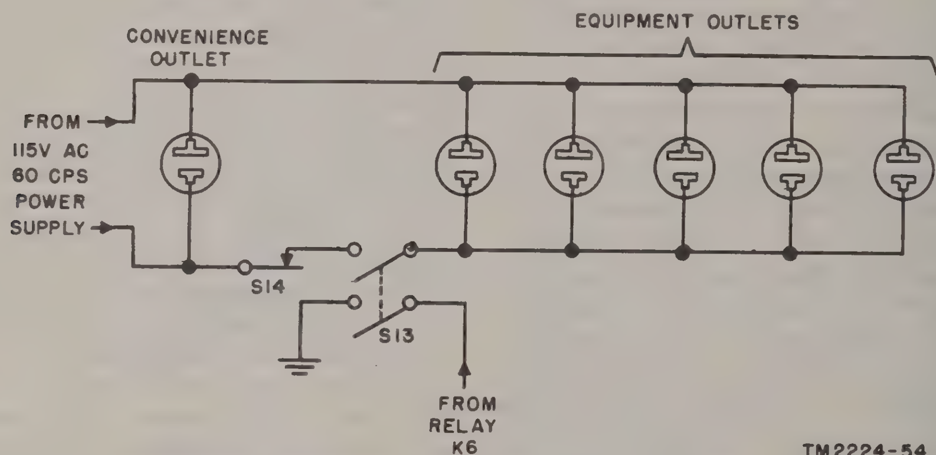


Figure 39. 115-volt ac power distribution circuit, schematic diagram.

Section XII. CONTROL CIRCUITS

108. General

Preliminary operating procedures for the teletypewriter test set are described in chapter 3. The theory of circuit function for these control operations are described in this section.

109. Voltage and Current Adjustments

a. When the power switch is turned to the OFF position, the BIAS meter should indicate zero and the TOTAL DIST meter should indicate minus five. When the power switch is turned to the ON position, with no signals being received, capacitors C208 and C209 or C210 and C211 (fig. 26) are connected to the reference voltage. They receive this voltage value and no current flows through the BIAS and TOTAL DIST meters, which should still indicate zero and minus five, respectively. The TOTAL DIST meter is part of the balanced Wheatstone bridge circuit described in paragraph 86 (fig. 30).

b. When POL CAL jack is patched to the TMS IN jack, polar signals are connected to relay K2. The armature of relay K2 follows the signals from a test unit that is usually sending the FOX test sentence. Insertion of the plug in the TMS IN jack furnishes a ground to operate relay K11 (fig. 40). When relay K11 operates, contact 11B supplies a 24-volt potential to contact 12B and operates relay K12. Relay K12 furnishes a ground to the winding of relay K7 so that it will operate when the ADJ SPD switch is operated. The operation of relay K12 also transfers the windings of relays K4 and K5 from a direct connection to the armature of relay K2 to a series connection containing contacts on the SIGS switch.

c. Operation of the SIGS switch to position M disconnects the armature of relay K2 and connects the +130-volt potential to the windings of relays K4 and K5, which then operate to their mark contacts. A constant current flows from the constant-current supply, through the CONST CUR meter, through resistor R208, through the contacts of the CAL switch, through contacts 3T and 4T of relay K1 to the stop-compensating voltage supply. The CONST CUR potentiometer is adjusted until the CONST CUR meter indicates 30 ma. The SC VOLT potentiometer is adjusted until the SC–REF VOLT meter indicates —55 volts. There is an interaction between the constant-current and stop-compensating voltage circuits (fig. 31); therefore, if either circuit requires adjustment the other has to be rechecked. The proper meter indications may be obtained by making fine adjustments.

d. When the REF VOLT switch is depressed, the SC–REF VOLT meter is transferred to the reference voltage circuit. The REF VOLT potentiometer can be adjusted until the meter indicates —55 volts.

110. Meter Distortion Adjustments

a. The proper position of the CHAR potentiometer during calibration is the midpoint between its limits of motion. The AMP ADJ potentiometer is turned fully clockwise, placing the maximum resistance in parallel with the TOTAL DIST meter to make the meter as sensitive as possible (fig. 30). The RESET switch is depressed momentarily to discharge capacitor C301. The ZERO ADJ potentiometer is adjusted so that the TOTAL DIST meter indicates zero. This balances the Wheatstone bridge legs HFJ and HGJ so that, with no signal on the teletypewriter test set, there is no current flowing through the TOTAL DIST meter. The SIGS switch is restored to normal and the test signals are permitted to operate relays K4 and K5.

b. The CAL switch is provided for adjusting maximum indications on the BIAS and TOTAL DIST meters. Operation of the CAL switch opens the comparison capacitor-discharging path from C208 and C209 to the mark contact of relay K4 and connects it to the SC VOLT potentiometer, through the operated contacts of the CAL switch (fig. 40). This makes the mark-to-space transitions ineffective because capacitors C208 and C209 always charge to the stop-compensating voltage, which is the same as the reference voltage. The space contact of relay K5 is disconnected from contact 3T of relay K1 (the capacitor-discharging lead) and is connected to the right side of resistor R15. When relay K5 operates to its space contact, capacitors C210 and C211 charge to the potential of the right side of resistor R15. This potential is the sum of the stop-compensating voltage plus the voltage drop across resistor R15. The current flows in this circuit from the stop-compensating supply through resistors R15 and R208, through the CONST CUR meter, to the constant-current supply. When the voltage on capacitors C210 and C211 is compared with the reference voltages, the bias indicated by the BIAS and TOTAL DIST meters will be the voltage differential across resistor R15:

$$\text{BIAS} = \text{SC VOLT} + (\text{I} \times \text{R15}) - \text{REF VOLT}$$
$$\text{SC VOLT} = \text{REF VOLT}$$
$$\text{BIAS} = \text{I} \times \text{R15} \text{ (the voltage across resistor R15).}$$

As the current supplied from constant-current supply does not change, the voltage across R15 will be constant. Resistor R15 is chosen so that with a constant current of 30 ma, a space distortion of 15 percent is created. Therefore, the BIAS meter can be calibrated by adjusting the BIAS potentiometer until the average indication is S15. The BIAS meter now is calibrated properly. The TOTAL DIST meter is calibrated by adjusting the AMP ADJ potentiometer until an indication of 10 is obtained on the TOTAL DIST meter, between operations of the RESET switch (fig. 30). The RESET switch is operated to remove the previous indication on the TOTAL DIST meter. The meter will hold the maximum reading unless capacitor C301 is discharged. The TOTAL DIST meter now indicates 10 instead of 15, because the meter is arranged so that with no current flowing through it, it indicates minus five. The TOTAL DIST meter is made to indicate zero in a later adjustment (ch. 3).

c. When the CAL and REV CAL switches are operated, the same calibrating conditions exist as described in paragraph 108, except that the current through the primary winding of input transformer T301 of the rectifier peak

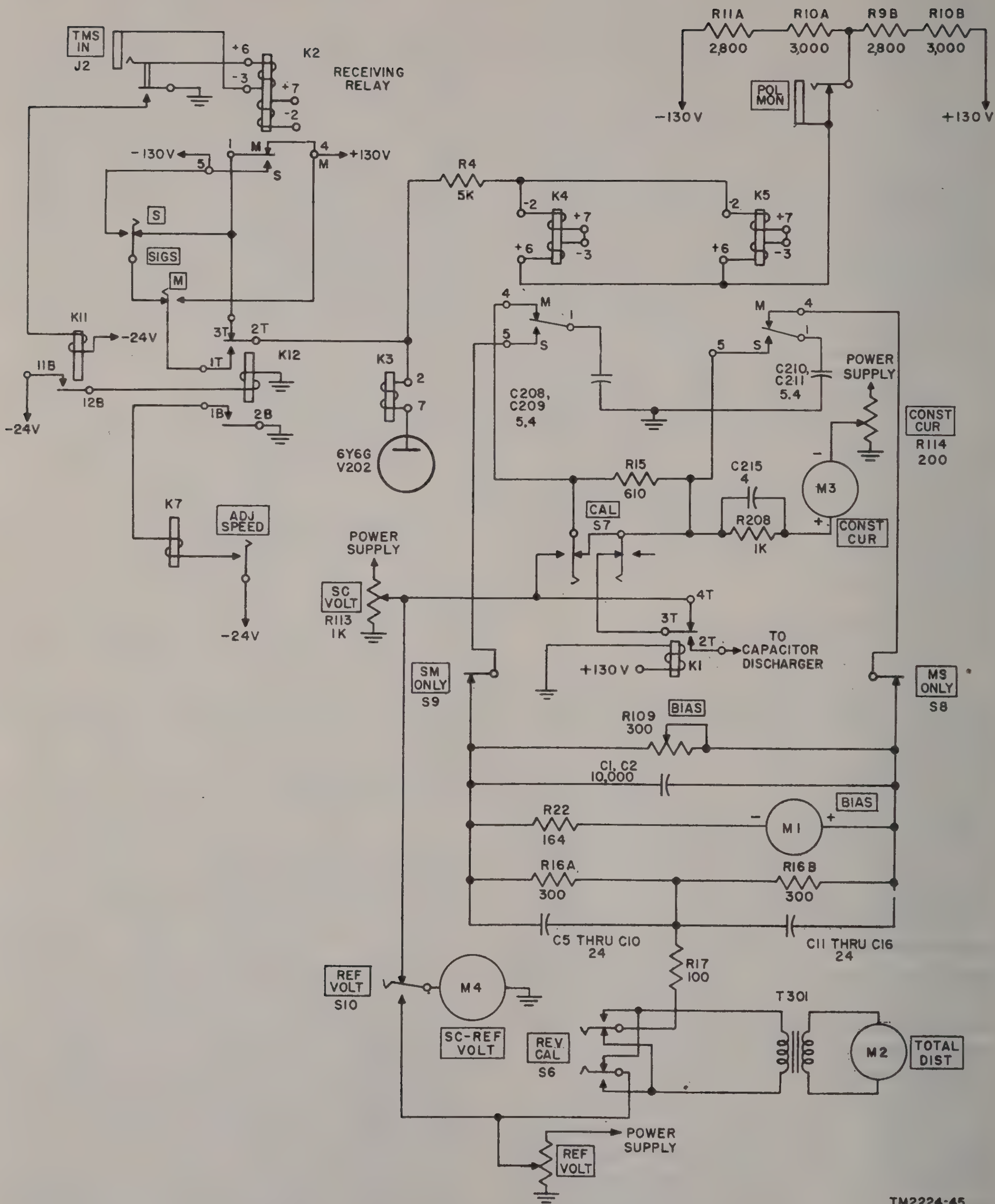


Figure 40. Calibrating circuit, simplified schematic diagram.

voltmeter is reversed (figs. 30 and 31). Therefore, the BIAS meter will still indicate S15 and the TOTAL DIST meter should indicate 10. If there is a difference of more than 1 percent between the indication of the TOTAL DIST meter when only the CAL switch or when the CAL and REV CAL switches are operated, rectifier tubes V301 and V302 should be checked for balance. As explained in paragraph 87, tubes V301 and V302 rectify the input signal, each tube acting independently, depending on which direction the current is flowing in the primary of input transformer T301. The release of the CAL and REV CAL switches restores the test circuit to normal.

111. Decrement Adjustments (figs. 26, 30, and 31)

a. The operation of the SIGS switch to S (figs. 26 and 31) operates relay K3 to its space contact. This permits continuous operation of the pulse oscillator circuit. The operation of the ADJ DECR switch permits measurement of the oscillator voltage by the TOTAL DIST meter. Starting with the midpoint of oscillator coil L202, the voltage developed across winding 4–3 is coupled through capacitors C227 and C228, through resistors R228 and R229 to ground. Resistors R228 and R229 act as voltage and decoupling resistors. The signal is taken from across resistor R229, through the operated ADJ DECR switch contacts (fig. 30) to the cathode of tube V301. The negative pulses are rectified and this voltage appears across capacitor C301, which causes the TOTAL DIST meter to indicate.

b. For the proper operation of the oscillator circuit, the DECR 60 potentiometer (fig. 26) should be adjusted so that the starting amplitude of the oscillator equals the steady-state amplitude of the oscillation. This will be an indication of about 35 on the TOTAL DIST meter.

c. When the DECR 60 potentiometer is turned counterclockwise, all of the resistance of the DECR 60 potentiometer is connected into the cathode circuit. Therefore, the steady-state amplitude of the oscillation will be smaller than the starting amplitude. As the test signals are being applied to the teletypewriter test set, the oscillator will start and stop for each character. Therefore, the TOTAL DIST meter will register the starting magnitude of the oscillation, because it is greater than the magnitude of the rest of the oscillation. When the SIGS switch is operated to S, relay K3 remains on its space contact and the oscillator will operate continuously. Relays K4 and K5 also will remain on their space contacts. The DECR 60 potentiometer now is adjusted until the indication on the TOTAL DIST meter is the same as the indication required in *b* above. The steady-state voltage of the oscillator now is of the same magnitude as the starting voltage. This should be rechecked by releasing the SIGS switch, observing the TOTAL DIST meter indication, reoperating the switch, and checking the TOTAL DIST meter again. The two indications should be identical. This calibration value should be recorded for future use. The procedure is repeated for speeds of 75 or 100 wpm.

112. Speed Adjustments

The correct speed of the distributor is adjusted when the ADJ SPD switch is operated. Figure 40 shows the operating circuit for relay K7. Relay K7 conditions the teletypewriter test set for adjustment of the distributor speed. When the teletypewriter test set is being calibrated, relay K11 operates and it, in turn, operates relay K12. Relay K12 furnishes a ground for relay K7, but relay K7 operates only when the ADJ SPD switch is operated to furnish battery supply.

a. Figure 41 is a simplified diagram of the comparison circuit and the speed-measuring circuit. The diagram shows the bias-measuring circuit in the normal condition. A simplified arrangement of the speed-measuring circuit without the relay contacts is shown in figure 42. Under normal conditions, relay K7 is not operated and the following conditions are obtained:

(1) The S contact of relay K4 is connected to the bias-measuring circuit through the S-M ONLY switch and contacts 1B and 2B of relay K7 (fig. 41). The M contact relay K5 is connected to the bias-measuring circuit through the M-S ONLY switch.

(2) The BIAS meter is connected to the BIAS potentiometer on one side through contacts 4B and 5B of relay K7 and on the other side through contacts 6T and 7T of relay K7.

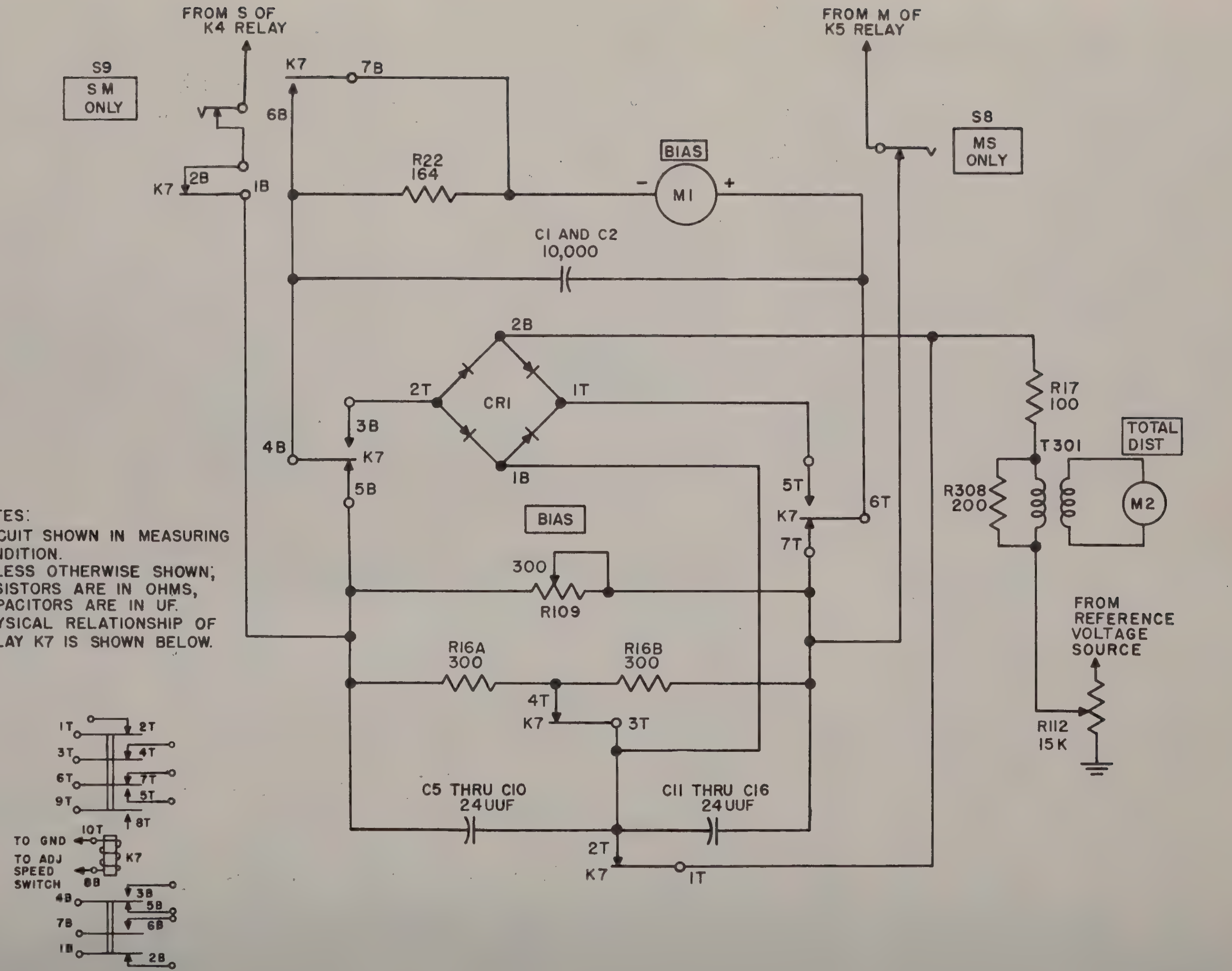


Figure 41. Comparison and speed-measuring circuit, simplified schematic diagram.

NOTES:
1. CIRCUIT SHOWN IN MEASURING CONDITION.
2. UNLESS OTHERWISE SHOWN; RESISTORS ARE IN OHMS, CAPACITORS ARE IN UF.
3. PHYSICAL RELATIONSHIP OF RELAY K7 IS SHOWN BELOW.

(3) The midpoint of resistor R16 is connected to the midpoint of capacitors C5 through C10 and C11 through C16 through contacts 3T and 4T of relay K7.

(4) The bias-measuring circuit is connected to the rectifying peak voltmeter circuit through contacts 1T and 2T of relay K7.

b. When the ADJ SPD switch is operated (fig. 40 and 41), relay K7 is operated and the following conditions are obtained:

(1) The S contact of relay K4 is opened by the opening of contacts 1B and 2B of relay K7.

(2) The BIAS meter is disconnected from the BIAS potentiometer by the opening of contacts 4B and 5B of relay K7. The BIAS meter is connected to 2T of varistor CR1 by the closing of contacts 3B and 4B of relay K7. The other side of the BIAS meter is disconnected from the BIAS potentiometer by the opening of contacts 6T and 7T. The BIAS meter is connected to 1T of varistor CR1 by the closing of contacts 5T and 6T of relay K7.

(3) The midpoint of resistor R16 is disconnected from the midpoint of capacitors C5 through C10 and C11 through C16 when contacts 3T and 4T of relay K7 open.

(4) The rectifying peak voltmeter is disconnected from capacitors C5 through C10 and C11 through C16 when contacts 1T and 2T of relay K7 open.

(5) When contacts 6B and 7B of relay K7 close, resistor R22 is shorted out. This permits maximum current through BIAS meter and increases its sensitivity.

(6) The speed-measuring circuit now is as shown in figure 42.

c. In figure 42, the S contact of relay K4 is open. When relay K5 is on the space contact, capacitors C210 and C211 charge from the constant-current source. When relay K5 is on the mark contact, capacitors C210 and C211 are connected to the measuring circuit. Because the signal being applied during calibration is a perfect signal and has negligible bias, any indication on the BIAS meter will be caused by an error between the speed of the distributor and the speed used for test source. The COARSE 60 and FINE 60 speed controls are adjusted until the BIAS meter reads zero.

(1) If the speed of the distributor circuit is too fast, capacitors C210 and C211 will not have charged sufficiently and the potential on them will be less negative than the reference voltage. Therefore, current will flow from capacitors C210 and C211 to the mark contact of relay K5 through resistor R16 and the BIAS potentiometer (in parallel) to capacitors C5 through C10. Current will also flow from contact M of relay K5 directly to capacitors C11 through C16. The voltage then will appear on 1B of varistor (rectifier) CR1 because of the transfer characteristics of the capacitors. Current flows from 1B to 1T of varistors CR1, from 1T of CR1 to the BIAS meter, through the BIAS meter to 2T of CR1, from 2T to 2B of varistor CR1, through the primary of the rectifying peak voltmeter to the reference voltage.

(2) If the speed of the distributor is too low, capacitors C210 and C211 will have been charged longer than they should have been and the potential on them will be more negative than the reference voltage. Current flows from the reference voltage through the rectifying peak voltmeter, from 2B to 1T of varistor CR1, through the BIAS meter, through 2T to 1B of varistor CR1, through the capacitor and resistor circuits to the mark contact of relay K5. (Note that the current flows through the BIAS meter in the same direction under both conditions.)

(3) The speed controls are adjusted until the BIAS meter indicates zero or a minimum value. The speed of the distributor now is the same as the test source. The ADJ SPD switch is restored to the unoperated position (fig. 40); this returns the circuit to its normal condition.

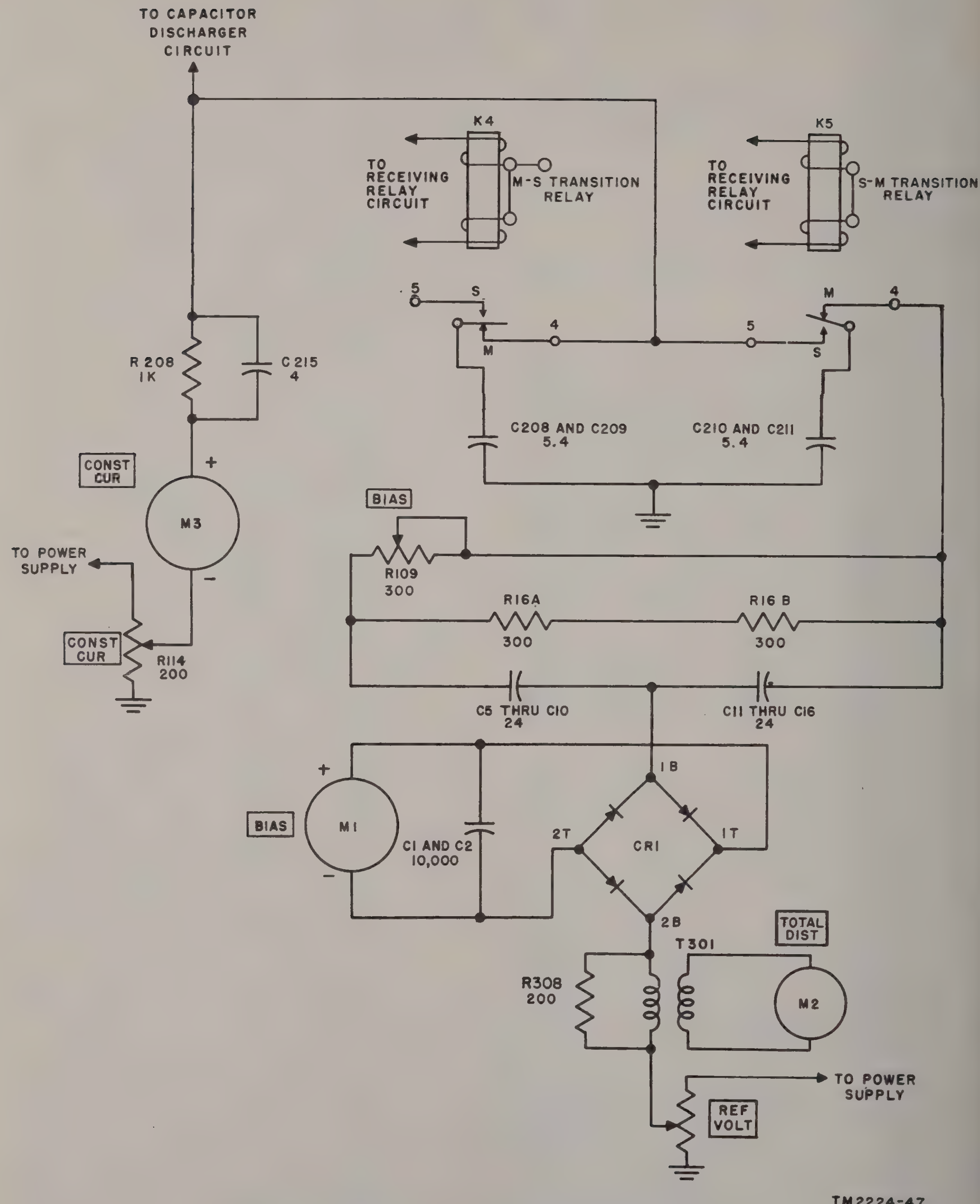


Figure 42. Speed-measuring circuit, simplified schematic diagram.

(4) Since there is no dc path between contact M of relay K5 and the reference voltage, only space-to-mark transitions are measured.

113. Orient Adjustments
(figs. 26 and 40)

The M–S ONLY switch is operated and the ORIENT 60 potentiometer is adjusted so that the BIAS meter indicates zero. When the M–S ONLY switch is operated, the bias in the external signal or in the teletypewriter test set does not affect the readings. Any BIAS meter indication is caused by misadjustments of the location of the ground interval (orientation). Therefore, adjusting the ORIENT 60 potentiometer until there is no BIAS meter indication, locates the proper point of discharge for the measuring capacitors. After this adjustment, the M–S ONLY switch is released.

CHAPTER 6

FIELD MAINTENANCE

Note. This chapter contains information for field maintenance. The amount of repair that can be performed by units having field maintenance responsibility is limited only by the tools and test equipment available and by the skill of the repairman.

Section I. TROUBLESHOOTING AT FIELD MAINTENANCE LEVEL

Warning: Dangerous voltages exist within the teletypewriter test set. Do not touch exposed terminals with the hands while the teletypewriter test set is connected to a source of power.

114. Troubleshooting Procedures

a. General. The first procedure, when servicing a defective teletypewriter test set, is to sectionalize the fault. Sectionalization means tracing the fault to a circuit responsible for the abnormal operation of the set. The second procedure is to localize the fault. Localization means tracing the fault to the defective part responsible for the abnormal condition. Some faults such as burned-out resistors and shorted transformers often can be located by sight, smell, or hearing. The majority of faults, however, must be localized by checking the voltage and resistance measurements.

b. Sectionalization and Localization. The procedures listed below are arranged to simplify and reduce unnecessary work and to aid in tracing a trouble to a specific part. Follow the procedures in sequence. Be careful not to cause further damage to the teletypewriter test set while it is being serviced. The service procedure is summarized as follows:

(1) *Visual inspection.* The purpose of visual inspection (par. 51) is to locate any visible trouble. Through inspection alone, one may frequently discover the trouble or determine the circuit in which the trouble exists. This type of inspection is valuable in avoiding additional damage to the teletypewriter test set.

(2) *Operational test.* When trouble is suspected in the teletypewriter test set, perform the operations listed in the equipment performance check list (par. 55). Observe any abnormal operation. Indications of abnormal operation are the symptoms of trouble that may be used in conjunction with the troubleshooting chart (par. 118).

(3) *Troubleshooting chart.* The troubleshooting chart lists symptoms of probable troubles in the teletypewriter test set. When the operational test is made, symptoms of trouble may be indicated. The troubleshooting chart will aid in locating and correcting many of the indicated troubles.

(4) *Intermittent troubles.* The possibility of an intermittent trouble should not be overlooked. If present, this type of trouble often may be made to appear by tapping or jarring the equipment. It is possible that some external connection may cause the trouble. Test wiring for loose connections and move wires and components with an insulated tool, such as a pencil or fiber rod. This may show where a faulty connection or component is located.

Caution: Be extremely careful when handling capacitors. With external power disconnected, a severe electrical shock may be received from a charged capacitor or from the leads connected to the capacitor.

115. Troubleshooting Data

The table below lists illustrations that will aid in locating troubles within the teletypewriter test set. The illustrations include schematic diagrams, wiring diagrams, part-location diagrams, and voltage and resistance diagrams.

a. Schematic Diagrams.

Figure No.	Title
25	Input circuit and measuring circuit, schematic diagram.
28	Distributor circuit, schematic diagram.
39	115-volt ac power distribution circuit, schematic diagram.
68	24-volt dc power supply circuit, schematic diagram.
69	Rectifying peak voltmeter circuit, schematic diagram.
70	Power supply circuit, schematic diagram.
71	Extension unit circuit, schematic diagram.
72	Regulated tube rectifier circuit, schematic diagram.
73	Teletypewriter Test Set TS–611A/FG, overall schematic diagram.

b. Wiring Diagrams.

Figure No.	Title
57	REG TUBE RECT +TG panel, wiring diagram.
58	REG TUBE RECT −TG panel, wiring diagram.
59	COMP CKT panel, wiring diagram.
60	RECT PEAK VM panel, wiring diagram.
61	DISTRIBUTOR panel, wiring diagram.
62	PWR SUP panel, wiring diagram.
63	24 VOLT SUP panel, wiring diagram.
64	EXT CKT panels, wiring diagram for extension relay circuits 1 through 15.
65	Extension unit, wiring diagram.
66	Ac supply circuit, wiring diagram.
67	Teletypewriter Test Set TS–611A/FG, interconnection diagram.

c. Part Location Diagrams.

Figure No.	Title
45	REG TUBE RECT panel, front view with cover removed.
46	REG TUBE RECT panel, rear view.
47	COMP CKT panel, front view.
48	RECT PEAK VM panel, rear view with radiation shield removed.
49	DISTRIBUTOR panel, rear view.
50	DISTRIBUTOR panel, terminal boards.
51	PWR SUP panel, rear view.
52	24 VOLT SUP panel, rear view.
53	EXT CKT panels, rear view.
54	Relay spring combinations.
55	MIL–STD resistor codes.
56	MIL–STD capacitor codes.

d. Voltage and Resistance Diagrams.

Figure No.	Title
43	Voltage and resistance values for distributor and rectifying peak voltmeter circuits.
44	Voltage and resistance values for the power supply circuit.

116. Tools, Materials, and Test Equipment

The following tools, materials, and test equipments are required for maintenance of Teletypewriter Test Set TS–611A/FG but are not supplied with the teletypewriter test set:

a. Tools.

Item	Commercial designation	Signal Corps stock No.
Spring adjuster	259	6R41059
Spring adjuster	300	6R41100
Spring adjuster	363	6R41163
Spring adjuster	505A	6R41305A
Spring adjuster	506A	6R41306A
Spring adjuster	507A	6R41307A
Spring tension gage	68B	6R40868B
Spring Tension Gage TL–558/U.	70H	6R40870H
Spring Tension Gage TL–559/U.	70J	6R40870J
Thickness gage	66D	6R40866D
Thickness gage	74D	6R40874D
Thickness gage	131A	6R40931A.3
Thickness gage	133A	6R40933A
Armature wedge	136B	6R40936B
Burnisher TL–557/U	265C	6R41065C
Switchboard Tool TL–338/U	206	6R41006
Screwdriver	207	6R41007
Relay tool	340	6R41140
Wrench	474A	6R41274A
Clip	508A	6R41308A
Lamp	510C	6Z6903
Screwdriver		6R15424
Screwdriver TL–44		6R15610
Pliers TL–126		6R4626
Pliers		6R4735–6.1
Soldering Iron TL–117		6R24617

b. Materials.

Item	Signal Corps stock No.
Orange stick	6Z7360
Brush	6Z1428
Cheesecloth, bleached	6Z1989
Cloth, emery; crocus	6Z2000
Paper, cleaning	6M750
Cleaning compound	
Solder, rosin core	6N7531
Toothpicks, hardwood	6Z8666
Cloth, lint-free	6N1624

c. Test Equipment.

Test equipment	Technical manual
Electron Tube Test Set TV–7/U	TM 11–5083
Test Set I–181	TM 11–2036
Test Set I–193A	TM 11–2513
Multimeter TS–297/U	TM 11–5500
Distortion Test Set TS–383/GG and TS–383A/GG.	TM 11–2217
Test Set TS–190/U	TM 11–2046

117. General Precautions

Whenever the teletypewriter test set is serviced, observe the following precautions:

a. Be careful when covers are removed from equipment and the microswitches are closed; *terminals with dangerous voltages are exposed.*

b. Careless replacement of parts often causes new faults.

(1) Before a part is removed, note the position of the leads. If the part has a number of connections, tag each lead before unsoldering it.

(2) Be careful not to damage other leads by pulling or pushing them out of the way.

(3) Do not allow drops of solder to fall into the teletypewriter test set; they may cause short circuits.

(4) A carelessly soldered connection may create a new fault. It is important to solder correctly, because *a poorly-soldered joint is one of the most difficult troubles to find.*

c. When servicing equipment, be careful not to disturb the setting of the various calibrating switches and potentiometers.

d. Use a voltohmmeter for continuity tests. Do not use a buzzer or test lamp because the amount of current used by these devices may permanently magnetize the cores of the transformers.

118. Troubleshooting Chart

Use the troubleshooting chart below to help locate troubles in the teletypewriter test set. The symptoms are listed in the order in which they are most likely to be detected when the installation and operating procedures (chs. 2 and 3) are followed. To use the chart effectively, follow the symptoms in the order in which they are presented. If a symptom of trouble listed in the chart appears in the equipment, clear the trouble before proceeding to the next symptom. The arrangement of entries in the chart is based on the assumption that at any particular point in the chart, all previously listed troubles have been cleared, or did not exist. Paragraph and figure references in the *corrective action* column refer to paragraphs and figures in the text which contain detailed information about the circuit suspected of being faulty. In addition, the overall schematic diagram (fig. 73) should be referred to as required.

Symptom	Probable trouble	Corrective action
1. Failure of ac power input. Tube filaments not lighted throughout the unit when 115-volt ac input is applied, toggle switch S13 on POWER SWITCH PANEL is turned to ON, rear door is closed, and all local circuit plugs are properly fused and plugged into their respective receptacles.	*a.* Ac line open	*a.* Check external 115-volt ac supply circuit for ground on white leg, 115 volts to ground on black *hot leg*, and external 20-ampere fuse in *hot leg*. If all are good, check splice in uppermost junction box in the teletypewriter test set. Repair defective condition as required (fig. 39 and par. 107).
	b. Toggle switch S13 on front of POWER SWITCH PANEL not properly closed.	*b.* Check operation of toggle switch and repair, if defective.
	c. Microswitch S14, which is operated by closure of rear door, not properly operating.	*c.* Check operation of microswitch by listening for audible click of switch upon hand operation of switch lever arm. If click is heard, see if door closure causes click. If door closure does not cause click, adjust lever arm so click occurs. If door closure does cause click, check for continuity through switch, and repair open circuit as required.

Symptom	Probable trouble	Corrective action
	d. Open circuit in ac supply circuit	*d.* Check for continuity and repair defective circuit as required.
2. Failure of regulated tube rectifiers		Measure −130 volts on strap side of resistor R25 of 24 VOLT SUP panel, and +130 volts on strap side of resistor R30 of the same panel. Voltages are measured between strap side and ground in each instance. Use voltmeter, observing proper polarities. If broken lead is suspected, trace from these points back to regulated tube rectifiers and check continuity. If continuity is proper, use resistors R25 and R30 as source of voltage measurement (fig. 25 and pars. 98–105).
a. Upon measurement, no 130-volt dc output.	(1) Fuse blown in regulated tube rectifier.	(1) Check fuses AC1 and AC2 and replace if defective.
	(2) Microswitch in regulated tube rectifier is inoperative or defective.	(2) Check operation of microswitch in same manner as symptom 1*c* above. If microswitch is good (causing timer to operate in 14–20 seconds and tubes to fire), check the seating of cover when thumb screws are tightened (par. 105).
	(3) Defective timer or open circuit leading to timer.	(3) If microswitch is good, and timer does not operate at any time after closure of microswitch, check for ac voltage on terminals 2 and 7 of relay K2. If no voltage appears on these pins, check ac circuit back to source and repair open circuit or replace defective component. If proper voltage (115 ±12 volts) appears on terminals 2 and 7, timer or timer circuit between K2 and K1 is probably defective. Check this circuit and repair open circuit and repair open circuit or replace defective component which may be either K2 or K1 or both (par. 104).
	(4) Defective tubes V1, V2, or associated tube circuits.	(4) If tubes do not fire when timer operates, even though tube filaments are lighted and grid caps are properly secured, replace tubes. If tubes still do not fire, check tube circuit for proper voltages (par. 120). Repair open circuits and replace defective components.
	(5) Inductor L1 or capacitors C1 through C8 short-circuited.	(5) If tubes fire, check for short in inductor L1 or capacitors C1 through C8 (par. 120).
b. Upon measurement, output voltage is too low or too high regardless of potentiometer R.	(1) Ac supply voltage too low or too high.	(1) Check incoming ac supply and attempt to provide at least 115 ±12 volts.

Symptom	Probable trouble	Corrective action
	(2) Defective tube (low emission) or tube circuit.	(2) Replace tube or check emission of tube on tube tester and replace if defective. If this does not correct condition, check filament voltage and tube voltages. Repair open circuits and replace defective components.
	(3) Overload condition	(3) Disconnect output leads at terminals 7 and 8 of terminal board B. If voltage across terminals 7 and 8 rises, then check for short or partial short in output circuit, external to the regulated tube rectifier, and clear condition. If voltage does not rise, disconnect output from terminals 2 and 6 of terminal board B and see if this removes the overload condition. If it does, check and clear external short in circuitry going to the 24 VOLT SUP panel. If the voltage does not rise, check for partial shorts in output of filter circuit or capacitors C1 through C8, inclusive. Correct defect in circuit or replace defective component.
	(4) Partial or complete breakdown of varistors H, A, and B; resistors A and B; potentiometer R; or other associated regulator circuits or components.	(4) Check grid bias voltage on tubes V1 and V2, terminal 4. This voltage should be approximately 3 volts more negative than the plate voltage (par. 102). Also check point-to-point voltages (par. 120).
	(5) Improper reference voltage	(5) Same as *b* (4) above (par. 103).
c. Erratic output voltage	(1) High tube firing point	(1) Replace tubes V1 and V2.
	(2) Loose connection, probably at one of the capacitors.	(2) Examine connection for cold soldered joint or loose connections, and correct when found.
3. Failure of 24-volt dc supply	*a.* Improper ac input to 24-volt supply.	*a.* If adjustment of potentiometer R601 does not result in output of 24 ±2 volts dc across terminals 5 and 6 of TB601, check ac input across terminals 1 and 2 of TB601. This should be 22 ±2 volts ac. If this does not appear, check circuit back to T1 of 130-volt power supplies. Trouble can be caused if windings of the two transformers T1 are not properly connected in series. Check for defect and correct (fig. 68, pars. 106 and 107).
	b. Aged rectifier CR610 unit	*b.* If proper voltage cannot be obtained by adjustment of R601, the rectifier unit could be seriously aged and should be replaced.
	c. Open or shorted resistor R601, or shorted capacitors C601 or C602.	*c.* Check continuity between components and across components, with circuit de-energized. If a capacitor is shorted, replace.

Symptom	Probable trouble	Corrective action
4. Irregular or no indication of CONST CUR and SC–REF VOLT meters.	a. Tube V102 defective b. Tube V101 and V103 defective c. Open circuit or defective part in power supply circuit. d. Dirty contacts on CAL switch	a. Replace tube (pars. 90 and 91). b. Replace tubes (pars. 90 and 91). c. Check voltages on tubes V101, V102, V103, V104, V105 of POWER SUP panel (fig. 44). If voltage reading is abnormal, check associated circuit for open or defective component and repair or replace, as required. d. Clean contacts.
5 Irregular or no indication on CONST CUR meter only.	a. Tube V105 on PWR SUP panel defective. b. Open circuit or defective component. c. Relay K1 contacts dirty	a. Replace tube. b. Same as 4*b* above (apply only to tube V105). c. Clean contacts.
6. SC–REF VOLT meter indicates unstable reference voltage for both operate and nonoperate positions of REF VOLT switch.	a. Tubes V104 and V106 on POWER SUP panel defective. b. Open circuit or defective component. c. REF VOLT switch contacts dirty d. No 130-volt supply	a. Replace tube. b. Same as for 4*c* above, except apply only to tubes V104 and V106. c. Clean contacts. d. Check in accordance with 2 above.
7. TOTAL DIST meter not restored to normal when RESET switch is operated.	a. Defective relay K301 or relay circuit, resulting in no ground on pin 3 of tube V303 of RECT PEAK VM panel upon operation of RESET switch. b. Defective tube V303 or defective tube circuit.	a. Placing external ground on pin 3 of tube V303 causes TOTAL DIST meter to restore itself. Check relay from pin 3 of tube V303 through contacts of relay K301 to ground. Also check circuit of relay K301 so that it will operate upon completing coil circuit to 24-volt battery. Correct defective circuit and components, as required. b. Placing external ground on pin 3 of tube V303 does not cause TOTAL DIST meter to restore itself. Check voltages of tube V303 (fig. 43). Replace tube or circuit component, or repair circuit, as required.
8. ZERO ADJ potentiometer has no control.	a. Defective tubes V303, V304 b. Blown plug fuse c. Defective transformer or associated circuit component. d. Defective component in bridge circuit.	a. When ZERO ADJ potentiometer setting is properly established, it changes balance of rectifying peak voltmeter bridge circuit, changing the current through the meter arm. If movement of ZERO ADJ potentiometer causes no deflection of meter indication, check voltages on tubes V303 and V304 (fig. 43). Replace tubes if defective. b. Check fuse in local panel ac plug. c. If voltages on tubes V303 and V304 are improper, check circuit associated with transformer T302, and repair defective circuit or replace defective component. d. Make continuity check and repair defective circuit or replace defective component.

Symptom	Probable trouble	Corrective action
9. When test message without distortion is transmitted into the teletypewriter test set and CAL switch is depressed, BIAS potentiometer cannot adjust BIAS meter to indicate −15% bias.	*a.* Relays K2, K4, and K5 defective	*a.* Check relay K2 to see that it is vibrating and following telegraph signal. If it does not appear to follow signal, replace relay. Also check to see that relays K4 and K5 follow signal; replace if defective.
	b. Relays K11 and K12 or associated circuit defective.	*b.* If relays K4 and K5 do not follow signal and are in adjustment, check K11, K12 relay circuits. Relays K11 and K12 should be in operate positions.
	c. SIGS switch or associated circuit defective.	*c.* If relays K11 and K12 are properly operated, check circuit from +130-volt regulated tube rectifier through contacts of K2 and K12 relays, to terminal 2 of relay K3 coil and replace defective component or repair defective circuit.
	d. BIAS meter or associated circuit defective.	*d.* Check BIAS meter, resistor 22, capacitors C1 and C2, and BIAS potentiometer for defective component or circuit and replace or repair as required.
	e. No reference voltage applied to BIAS meter circuit.	*e.* No indication on BIAS meter requires check through series circuit from REF VOLT potentiometer through REV CAL switch through transformer T301 and resistor R17 to BIAS meter circuit. Read −55 volts from center point of resistor R16 to ground. If this voltage does not appear, repair circuit or replace defective component.
	f. Defective charging capacitors	*f.* Measuring capacitors leaky. Check and replace as required. If test equipment is available for operation at other speeds and symptom 9 does not occur, check measuring capacitor circuit.
10. TOTAL DIST meter cannot be adjusted to +10% when CAL switch is operated.	*a.* Defective tubes V301, V302	*a.* Replace tubes.
	b. Associated tube circuit defective	*b.* Check readings on pins of tubes V301, and V302 (fig. 43). Check associated tube circuit and replace defective components or repair defective circuit. This includes ADJ DECR switch. If this check shows this circuit to be good, check circuit through capacitor C303, resistor R308 and transformer T301, coil 1–4 and repair circuit or replace defective component.
11. When CAL and REV CAL switches are depressed, BIAS and TOTAL DIST meters do not indicate.	Defective REV CAL switch	Check circuit through REV CAL switch and repair circuit or replace defective component.

Symptom	Probable trouble	Corrective action
12. When CAL and REV CAL switches are depressed, TOTAL DIST meter does not indicate within 1% as required.	*a.* Tubes V301 and V302 not balanced.	*a.* Interchange tubes. If tubes are still unbalanced replace each tube, one at a time, with another. Mutual conductance of tubes should be within 5% of each other as determined by a tube tester.
	b. Circuit unbalanced because of mismatch of components.	*b.* Check circuit components associated with tubes V301 and V302 and rematch components as required.
13. When ADJ DECR and SIGS switches are operated, there is either no indication on the TOTAL DIST meter or an unsteady indication.	*a.* Relay K3 or its associated circuit defective.	*a.* Block relay K3 to space position (left-hand contact). This removes negative bias from grid of pulse oscillator tube V203, and simulates action which should have occurred had the function of the SIGS switch (in the S position) caused the proper operation of the relay. If TOTAL DIST meter indication is corrected, check adjustment of relay K3 and associated circuit through SIGS switch and repair defective circuit or component.
	b. Pulse oscillator circuit	*b.* Check for ac voltage across resistor R229 of DISTRIBUTOR panel. This voltage should vary with movement of DECR potentiometer. If voltage does not appear or does not vary with movement of DECR potentiometer, replace tube V203. If this does not correct condition, check voltages on pins of tube V203 (fig. 43); then check associated circuits of oscillator as required, and replace defective components or repair defective circuiting.
	c. ADJ DECR switch or associated circuit defective.	*c.* If voltage of 13*b* above is properly obtained across resistor R229, but does not appear across pin 4 of V301, check ADJ DECR switch circuit from resistor R229 to pin 4 of tube V301 and repair or replace defective circuit or components.
	d. Defective speed control circuit	*d.* Check for shorts in variable capacitor circuit associated with speed control. (If equipment is available for operation at other speed and symptom 13 does not occur, the trouble is probably in the speed control capacitor circuit.)
14. Adjusting SPEED controls have no effects or unsteady effects on the BIAS meter speed indication, with ADJ SPD switch operated.	*a.* Relay K7 not operated	*a.* Block relay K7 to operate position. If this corrects condition, check K7 coil circuit from ground to 24-volt battery through ADJ SPD switch contacts and repair or replace defective circuit or component as required.

Symptom	Probable trouble	Corrective action
	b. Relay K7 contact not properly closed or defect in associated contact circuits.	*b.* Use a dc voltmeter and check for presence of telegraph pulses across 2B and 1B of CR1 by noting corresponding pulsing of voltmeter needle with variation of SPEED controls. (This voltage is less than 55 volts.) If pulsing is not proper or does not appear, check for circuit continuity through contacts 1T, 2T, 3T, 4T of relay K7 and repair or replace defective circuit or components.
	c. No reference voltage supply	*c.* If voltage across 2B and 1B of CR1 appears extraordinarily high, block relay K7 to nonoperate position and measure reference voltage at 2B of CR1. This should be −55 volts dc. If this voltage does not appear, check for circuit continuity from reference voltage supply point to 2B of CR1 and repair or replace defective circuit or component.
	d. No input from CR1 to BIAS meter	*d.* With SPEED control adjusted to give maximum dc output of CR1, this same output should appear across BIAS meter terminals. If the output of CR1 appears across the BIAS meter terminals, but is insufficient to cause BIAS meter to read or indication is unsteady, replace CR1. If the output does not appear across BIAS meter, check for continuity from 1T and 2T of CR1 through relay K7 contacts to the + and − terminals of the BIAS meter, respectively. Repair defective circuit or replace defective component.
15. When adjusting ORIENT potentiometer with M–S ONLY switch operated, zero bias indication cannot be obtained on BIAS meter. For this symptom, operation at other speeds is advisable, since good operation will establish all common circuits as good, with possible trouble remaining in ORIENT potentiometer and capacitor C206 or C207 circuits of capacitor discharger.	(1) Tubes V201, V202, V203, V204, or V205 defective. (2) Associated tube circuits defective.	(1) Replace tubes one at a time with good tubes. (2) Check voltages on pins of tubes V201, V202, V203, V204, and V205 (fig. 43). If voltages are improper, check associated tube circuits and components and repair or replace defective circuits or component.
a. Tube V204 glows but tube V205 does not glow.	*a.* Defective resistors R32, R222, R223, capacitor C14 or C226, or varistors CR201 through CR206.	*a.* Replace defective resistors, capacitors, or varistors or repair defective circuit.
b. Tube V205 flashes over falsely	*b.* Defective varistors CR207 through CR210 or associated circuits.	*b.* Replace defective components or repair defective circuits.

Symptom	Probable trouble	Corrective action
16. Slight bias indication on meters after teletypewriter test set has been calibrated and a distortion-free test sentence is being measured.	Slight inconsistencies in polar relay adjustments.	Interchange polar relays and recalibrate teletypewriter test set. If this does not work, readjust relays.
17. BIAS meter readings erratic	Open capacitors C1 and C2	Replace defective capacitors.
18. Circuit functions properly on one type of input but not on other.		
a. Circuit does not function properly on .060 ampere, neutral operation.	*a.* Open or shorted resistor R12 or R13 or dirty contacts 1T–2T or 1B–2B of relay K8 or 2T–3T or 2B–3B of relay K9.	*a.* Replace or repair defective component or circuit.
b. Circuit does not function properly on polar operation.	*b.* Open circuit in POL switch or relay circuit K8 or relay K8 out of adjustment.	*b.* Replace or repair defective component or circuit, as required, or readjust relay K8.
c. Circuit does not function properly on .020 ampere, neutral operation.	*c.* Open circuit in POL–.060A-.020A switch or relay K9.	*c.* Replace or repair defective component or circuit, as required, or readjust relay K9.

Note. The troubles below pertain to those portions of the circuit which are peculiar to the type of switching involved. It is assumed that the common circuits are free of trouble.

Symptom	Probable trouble	Corrective action
19. Proper functioning at one speed but not at another.		
a. Does not work at 100 wpm	(1) K203 does not operate or its associated circuits are defective.	(1) K203 does not operate, check relay K203 circuit for continuity through coil. If circuit is good, relay is defective or out of adjustment.
	(2) K202 does not operate or its associated circuits are defective.	(2) Same as (1) above, except that it is applicable to relay K202 only.
	(3) CHG SPD switch, SPEED 75–100 switch or capacitor C216, C217, C218, C221, C222, C204, C201, C202, C203 defective.	(3) CHG SPD or SPEED 75–100 switch does not cut in appropriate capacitors, or capacitors are defective. Check circuit and repair defective circuit or replace defective capacitors.
	(4) DECR 75–100 potentiometer or associated circuit defective.	(4) If no control is apparent with variation of DECR potentiometer, check associated circuit for defective component or circuit and repair or replace as required.
	(5) ORIENT 75–100 potentiometer or associated circuit defective.	(5) If BIAS meter indication for orientation position of the calibration cannot be adjusted by varying the ORIENT 75–100 potentiometer, check ORIENT 75–100 potentiometer and its associated circuit for defective component or circuit and replace or repair as required.
b. Does not work at 60 wpm	(1) Relays K201, 202, 203 or associated circuits or components defective.	(1) If relay K201, K202, or K203 operate, relay or associated circuits or components are defective. Check circuits and components and repair or replace, as required.
	(2) CHG SPD switch, or capacitor C208, C209, C210, C211, C217, C219, C223, or C224 defective.	(2) Same as *a*(3) above, except that SPEED 75–100 switch does not apply.
	(3) DECR 60 potentiometer or associated circuit defective.	(3) Same as *a*(4) above.

Symptom	Probable trouble	Corrective action
	(4) ORIENT 60 potentiometer or associated circuit defective.	(4) Same as *a*(5) above.
c. Does not work at 75 wpm	(1) Same as *a*(1) above (2) Same as *a*(2) above (3) Same as *a*(3) above, except applicable to capacitor C212, C213, C216, C217, or C218, C221, C222. (4) Same as *a*(4) above (5) Same as *a*(5) above	(1) Same as *a*(1) above. (2) Same as *a*(2) above. (3) Same as *a*(3) above. (4) Same as *a*(4) above. (5) Same as *a*(5) above.
20. Plugging in at the TMS IN jack at an extension results in no indication of transmitted signal on local extension meter.	*a.* Relay K16 (ext 1), K18 (ext 2), K20 (ext 3), etc. or associated circuit is defective. *b.* Ground or short at an extension location, or open circuit in series loop cabling.	*a.* If this occurs for only one extension, the trouble is in the local extension unit circuit or component. Check local circuit or components and repair or replace as required. (Relay K16 (ext 1) etc. should operate when the plug is placed in the TMS IN jacks.) *b.* If this occurs for all extensions, the trouble is in the series circuit supplying 24 volts dc to the coil of relay K10 of the teletypewriter test set. Check circuit or components and repair or replace as required.
21. Meters at an unused extension show that the circuit is in use, but the BSY lamp is not lighted as required. (BSY lamp, at used extension only should be unlighted.)	*a.* Defective lamp *b.* Defective local extension circuit through contact of local extension relay (K16 for ext 1), etc. *c.* Same as 20*b* above	*a.* Change lamp. *b.* If this occurs for only one extension, the trouble is in the local extension unit circuit or components. Check local circuit or components and repair or replace as required. *c.* If this occurs for all extensions, the trouble is in the series circuit which is completed to ground through the 4B contact of relay K10. Check circuit or component and repair or replace as required.
22. When the circuit is in use at an extension, the user does not receive the challenging signal of another extension desiring to use circuit.	*a.* Same as 20*a* except probably applicable to the 5T and 4T contacts of the relay. *b.* Same as 20*b*	*a.* If only one extension cannot challenge, the trouble is in the local extension unit circuit or component. Check local circuit or components and repair or replace as required. Relay K16 (ext 1) etc. of challenger should not operate when the plug for that extension is placed in the TMS IN jack and the circuit is already in use. *b.* If all extensions cannot challenge, check the circuit from the extensions to the relay K15.
23. Changing speed at an extension results in erroneous meter indications.	CHG SPD switch or associated circuit defective as noted by failure of proper operation of relays K202 and K203.	If K202 and K203 do not operate when SPD 75/100 switch at one extension is in 75/100 position, check associated circuit at local extension position. Replace or repair defective components or circuits.

Symptom	Probable trouble	Corrective action
		If K202 and K203 do not operate when SPD 75/100 switch at more than one extension is in 75/100 position, check common circuit back to and including relays K202 and K203 at the test set. Replace and repair defective components or circuits as required.
24. BSY lamp does not flash at 120 ipm when attempting to measure a 100 wpm signal at an extension, with the teletypewriter test set at 75 wpm and 6-code operation.	*a.* Local extension circuit through contacts 8B and 9B of relay K16 (for ext 1), K18 (for ext 2) etc., is defective.	*a.* If this occurs at only one extension, the trouble is in the local extension circuit through contacts 8B and 9B of relay K16 (for ext 1), etc. Check the circuit and repair or replace defective circuit, or components.
	b. Open circuit in series loop cabling from extensions through and including relay K13, the CODE 6–5 and SPEED 75–100 switch of the teletypewriter test set.	*b.* If this occurs at all extensions, the trouble is in the common circuit back through and including the relay K13, the CODE 6–5 and the SPEED 75–100 switch of the test set. Check the circuit and repair or replace defective circuit or components.
25. Operation of POL–.060A–.020A switch at extension results in erroneous meter indications.	*a.* Defective POL–.060A–.020A ampere switch or associated circuit at local extension.	*a.* When for one extension this key is operated to POL and relay K8 does not operate at teletypewriter test set, check POL–.060A–.020A switch circuit at extension and repair or replace defective circuit or component.
	b. Defective common circuit from extensions to and including relay K8 of the teletypewriter test set.	*b.* When for all extensions, the switch is operated to POL and relay K8 does not operate at main unit, check the main circuit back through relay K8 of the teletypewriter test set and repair or replace defective circuit or component.
	c. Same as *a* above	*c.* Same as *a* above except that switch is operated to .020A and relay K9 does not operate at teletypewriter test set in place of relay K8.
	d. Defective common circuit from extensions to and including relay K9 of the teletypewriter test set.	*d.* Same as *b* above except that switch is operated to .020A and relay K9 does not operate at teletypewriter test set in place of relay K8.
26. TOTAL DIST meter does not reset when RESET switch at extension is operated.	*a.* RESET switch or associated circuit at local extension.	*a.* When for one extension, RESET switch is depressed and relay K301 does not operate, check RESET switch and associated circuit at the local extension and repair or replace defective circuit or component.

Symptom	Probable trouble	Corrective action
	b. Common circuit from extensions through relay K301 of teletypewriter test set.	*b.* When for all extensions, RESET switch is depressed and relay K301 does not operate, check common RESET switch circuit from the extensions through relay K301 of teletypewriter test set and repair or replace defective circuit or component.
27. SIGS lamp at extension does not flash in conjunction with transmitted signal.	*a.* Defective lamp at extension	*a.* Replace lamp.
	b. Defective extension relay K17 (ext 1), K19 (ext 2) etc., or associated local extension circuit.	*b.* When this occurs for one extension, check local extension circuit through local relay K17 (ext 1), K19 (ext 2), etc. and repair or replace defective circuit or component.
	c. Common circuit from extensions to L203 of distributor panel defective.	*c.* When this occurs for all extensions, check common circuit from extensions to L203 of capacitor discharger circuit on distributor panel and repair or replace defective circuit or component.

119. Selection of Tube V106 for Power Supply

To maintain low variation of the constant-current supply, select a 2A5-type tube with high filament activity. A tube of this type can be selected from a number of tubes tested in the manner described in *a* through *e* below.

a. Set the controls of Electron Tube Tester TV–7/U for use with tube 2A5.

b. Adjust the sensitivity control to obtain a meter indication of 2,000 micromhos.

c. Set the filament voltage control to the 2-volt position.

d. Read the meter after 30 seconds.

e. Select and use the tube that gives meter indication closest to 2,000 micromhos.

120. Voltage and Resistance Measurements

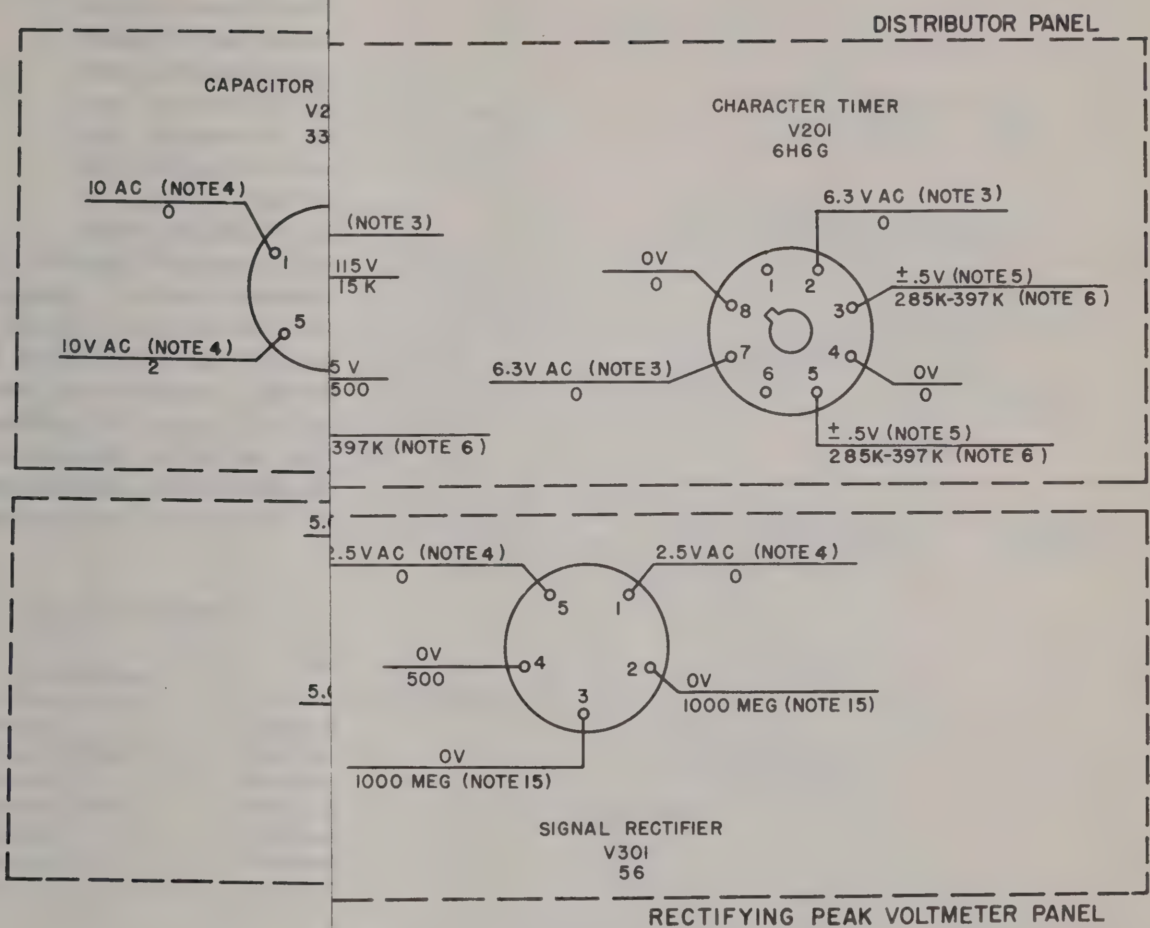
a. General. Voltage and resistance measurements aid in locating some troubles in the teletypewriter test set. The purpose of some precautions that should be considered while measuring voltages in the 130-volt regulated tube rectifiers is explained in *b* below. Measurements that can be made at the tube sockets are explained in *c* below. Measurements that can be made at the 130-volt regulated tube rectifiers are explained in *d* below. All voltage references are based on results obtained with a 1,000 ohm-per-volt voltmeter unless otherwise indicated.

b. Precautions. Do not touch terminals in the teletypewriter test set with the hands; dangerous voltages are present. Do not allow the test probe to touch two metal parts in the teletypewriter test set at the same time, because destructive and dangerous shorts may occur. When resistance measurements are being made, disconnect power from the unit under test and discharge the power filter capacitors by grounding their terminals to the chassis with a piece of insulated wire.

c. Tube-Socket Voltage and Resistance Measurements.

(1) *Filament voltages.* The filament voltages for the tubes in each subcircuit of the teletypewriter test set are obtained from the transformers which are part of that subcircuit. For example, the filament voltage for the tubes in the rectifying peak voltmeter circuit is obtained from transformer T302 in that circuit. The only exception is the filament voltage for tube V106 in the power supply circuit. This filament voltage is obtained from a transformer in the distributor circuit.

(2) *Plate voltage.* Plate voltage for tubes



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Symptom	Probable trouble	Corrective action
	b. Common circuit from extensions through relay K301 of teletypewriter test set.	*b.* When for all extensions, RESET switch is depressed and relay K301 does not operate, check common RESET switch circuit from the extensions through relay K301 of teletypewriter test set and repair or replace defective circuit or component.
27. SIGS lamp at extension does not flash in conjunction with transmitted signal.	*a.* Defective lamp at extension-------	*a.* Replace lamp.
	b. Defective extension relay K17 (ext 1), K19 (ext 2) etc., or associated local extension circuit.	*b.* When this occurs for one extension, check local extension circuit through local relay K17 (ext 1), K19 (ext 2), etc. and repair or replace defective circuit or component.
	c. Common circuit from extensions to L203 of distributor panel defective.	*c.* When this occurs for all extensions, check common circuit from extensions to L203 of capacitor discharger circuit on distributor panel and repair or replace defective circuit or component.

119. Selection of Tube V106 for Power Supply

To maintain low variation of the constant-current supply, select a 2A5-type tube with high filament activity. A tube of this type can be selected from a number of tubes tested in the manner described in *a* through *e* below.

a. Set the controls of Electron Tube Tester TV–7/U for use with tube 2A5.

b. Adjust the sensitivity control to obtain a meter indication of 2,000 micromhos.

c. Set the filament voltage control to the 2-volt position.

d. Read the meter after 30 seconds.

e. Select and use the tube that gives meter indication closest to 2,000 micromhos.

120. Voltage and Resistance Measurements

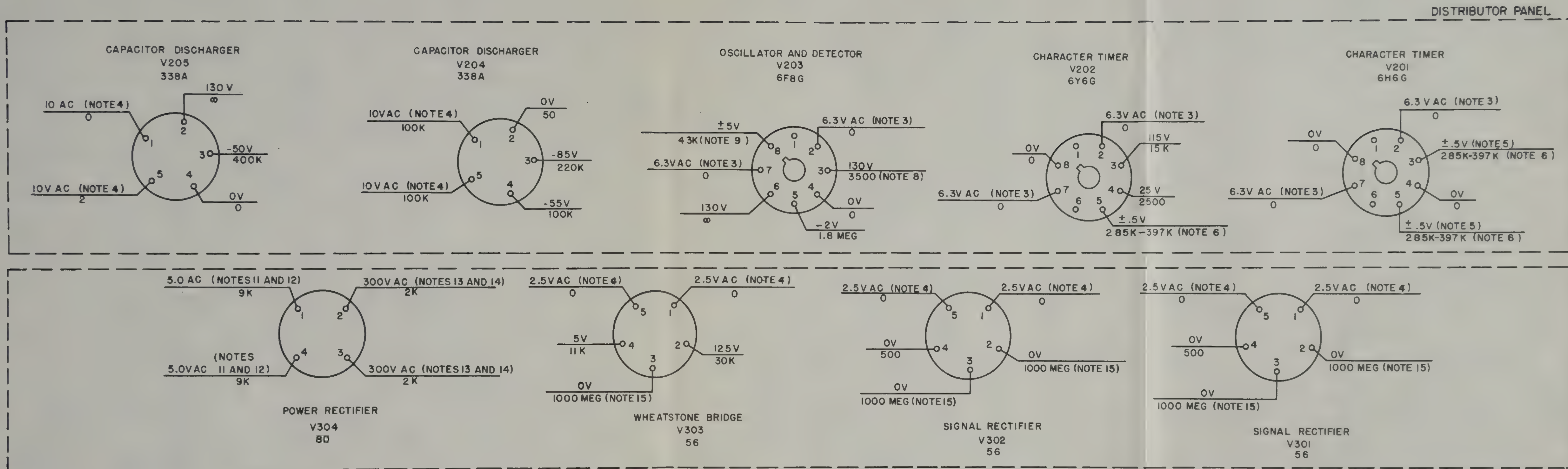
a. General. Voltage and resistance measurements aid in locating some troubles in the teletypewriter test set. The purpose of some precautions that should be considered while measuring voltages in the 130-volt regulated tube rectifiers is explained in *b* below. Measurements that can be made at the tube sockets are explained in *c* below. Measurements that can be made at the 130-volt regulated tube rectifiers are explained in *d* below. All voltage references are based on results obtained with a 1,000 ohm-per-volt voltmeter unless otherwise indicated.

b. Precautions. Do not touch terminals in the teletypewriter test set with the hands; dangerous voltages are present. Do not allow the test probe to touch two metal parts in the teletypewriter test set at the same time, because destructive and dangerous shorts may occur. When resistance measurements are being made, disconnect power from the unit under test and discharge the power filter capacitors by grounding their terminals to the chassis with a piece of insulated wire.

c. Tube-Socket Voltage and Resistance Measurements.

(1) *Filament voltages.* The filament voltages for the tubes in each subcircuit of the teletypewriter test set are obtained from the transformers which are part of that subcircuit. For example, the filament voltage for the tubes in the rectifying peak voltmeter circuit is obtained from transformer T302 in that circuit. The only exception is the filament voltage for tube V106 in the power supply circuit. This filament voltage is obtained from a transformer in the distributor circuit.

(2) *Plate voltage.* Plate voltage for tubes



NOTES:

1. VOLTAGES MEASURED TO GROUND, UNLESS OTHERWISE INDICATED, WITH A 1000 OHMS-PER-VOLT METER.
2. ALL RESISTANCE MEASUREMENTS MADE WITH THE POWER OFF AND FILTER CAPACITORS DISCHARGED.
3. MEASURED BETWEEN TERMINALS 2 AND 7.
4. MEASURED BETWEEN TERMINALS 1 AND 5.
5. +130 VOLTS WHEN TUBE V201 IS REMOVED FROM SOCKET.
6. RESISTANCE DEPENDS ON POSITION OF CHAR POTENTIOMETER.
7. RESISTANCE DEPENDS ON POSITION OF DECR 60 POTENTIOMETER.
8. LUG 4 OF TB 201 GROUNDED WITH CLIP.
9. RESISTANCE DEPENDS ON POSITION OF DECR 60 POTENTIOMETER.
10. VOLTAGE DEPENDS ON POSITION OF ORIENT 60 POTENTIOMETER.
11. MEASURED BETWEEN TERMINALS 1 AND 4.
12. MEASURED TO GROUND + 200 VOLTS.
13. MEASURE TO TERMINAL 9 OF TRANSFORMER T302.
14. MEASURED TO GROUND −50 VOLTS.
15. MEASURE WITH VACUUM TUBE VOLTMETER.
16. ALL VOLTAGES DC UNLESS OTHERWISE INDICATED.
17. ALL RESISTANCES IN OHMS UNLESS OTHERWISE INDICATED.
18. ALL VOLTAGES POSITIVE UNLESS OTHERWISE INDICATED.

Figure 43. Voltage and resistance values for distributor and rectifying peak voltmeter circuits.

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in the distributor circuit is obtained from the +130-volt regulated tube rectifier. Plate voltage for tubes in the rectifying peak voltmeter circuit and in the power supply circuit is obtained from transformers which are part of those circuits.

(3) *Voltage and resistance data.* Figure 43 indicates the voltage and resistance values which should be obtained at the tube sockets of the distributor circuit and the rectifier peak voltmeter circuit. Figure 44 indicates the voltage and resistance values which should be obtained at the tube sockets of the power supply circuit.

d. 130-volt Regulated Tube Rectifier Measurements. Voltage measurements can be made at the 130-volt regulated tube rectifiers when the front covers are removed. Removal of a front cover causes a microswitch to release, breaking the circuit for the ac input power. The ac input circuit can be closed by manually operating the microswitch while voltage measurements are being made. Tape can be used to hold the microswitch in the desired position, but it should be removed upon completion of measurements. If it is necessary to open the rear door of the teletypewriter test set while voltage measurements are being made, the microswitch on the rear of the teletypewriter test set must also be operated manually. The chart below indicates the voltage values which should be obtained between designated terminals of the 130-volt regulated tube rectifiers.

(1) *Ac voltages.*

Item being checked	Connect voltmeter between terminals	Meter indications
Power supply input	1 and 2 on transformer T1.	115
Varistor A and B input.	2 of varistor A, and 2 of varistor B.	54
Varistor H input	15 and 16 of transformer T1.	15
Ac output	5 and 6 of terminal strip ac.	6.4
Filament	2 and 7 of tube V1 and V2.	2.4

(2) *Dc voltages.*

Item being checked	Connect positive terminal of voltmeter to	Connect negative terminal of voltmeter to	Meter indications
Grid bias	Positive terminal of capacitor C3	Rear terminal capacitor A	2–4
Reference voltage	Rear terminal of capacitor F	Front terminal of capacitor F	42–50
Resistor A	Positive terminal of capacitor C3	Terminal 3 of rheostat R	31
Varistor H output	Terminal 1 of varistor H	Rear terminal of capacitor A	11.8
Resistor G	Terminal 1 of varistor H	Rear terminal of capacitor F	1.4
Inductance L1	Terminal 1 of inductance L1	Terminal 2 of inductance L1	3.8

Section II. REPAIRS

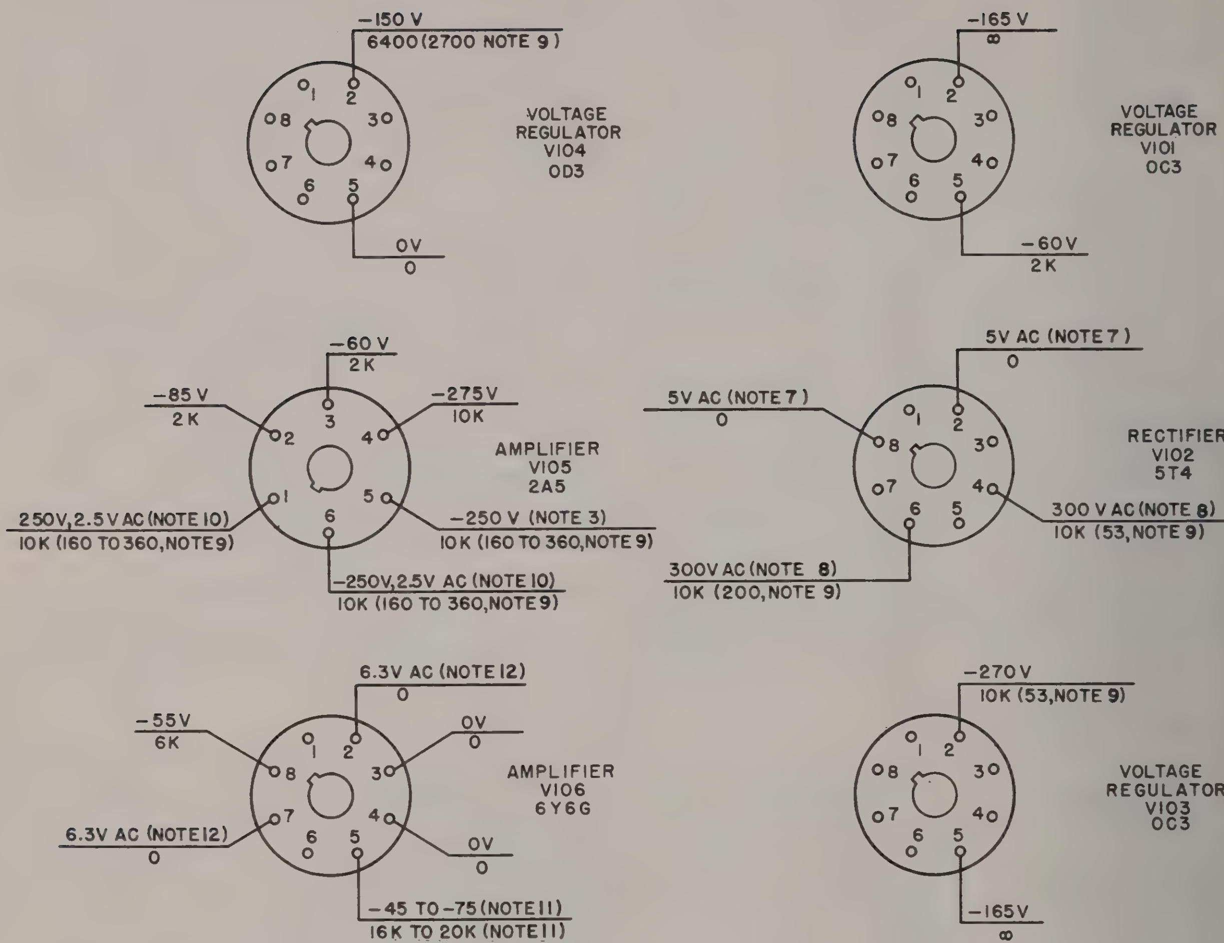
121. Replacement of Defective Parts and Refinishing

Replace defective parts with exact duplicates. Resistors and capacitors used as replacements must have the same resistance, capacitance and power ratings as the parts they replace. Tubes, meters, lamps, transformers, and reactors must be replaced with equivalent parts.

a. Most parts of the teletypewriter test set are readily accessible. These parts may be reached after opening the door at the rear of the teletypewriter test set cabinet.

b. The entire rear of the rectifying peak voltmeter is covered with a radiation shield. To remove the shield, remove the plug from the ac supply circuit receptacle at the rear of the rectifying peak voltmeter. Grasp the radiation shield on both sides between the palms of the hands and draw the shield back toward the body with an even tension. Always replace the radiation shield when a repair is completed. Failure to replace the radiation shield will leave high-voltage terminals exposed and will result in faulty operation of the teletypewriter test set.

c. Each power transformer is covered with a steel box and cover. To remove a cover, loosen



NOTES:

1. VOLTAGES MEASURED TO GROUND, UNLESS OTHERWISE INDICATED, WITH A 1,000 OHMS-PER-VOLT METER.
2. ALL RESISTANCE MEASUREMENTS MADE WITH THE POWER OFF AND FILTER CAPACITORS DISCHARGED.
3. DEPENDING ON POSITION OF CONST CUR POTENTIOMETER.
4. ALL VOLTAGES DC UNLESS OTHERWISE INDICATED.
5. ALL RESISTANCES ARE IN OHMS UNLESS OTHERWISE INDICATED.
6. ALL VOLTAGES POSITIVE UNLESS OTHERWISE INDICATED.
7. MEASURED BETWEEN TERMINALS 2 AND 8.
8. MEASURED BETWEEN TERMINAL 4 OR 6 AND TERMINAL 4 OF INDUCTANCE L101.
9. WITH LUG 1 OF INDUCTANCE L101 GROUNDED.
10. AC VOLTAGE MEASURED BETWEEN TERMINALS 1 AND 6.
11. DEPENDING ON POSITION OF REF VOLT SWITCH.
12. MEASURED BETWEEN TERMINALS 2 AND 7.

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Figure 44. Voltage and resistance values for the power supply circuits.

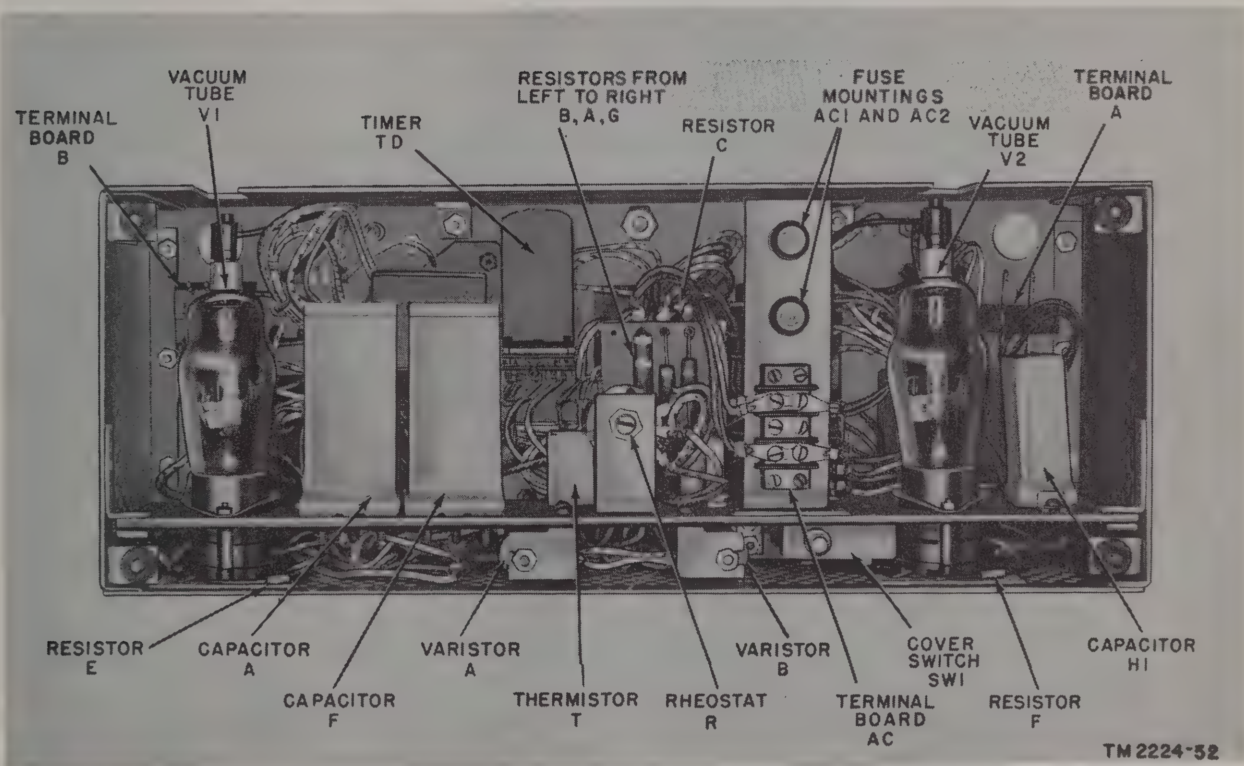

Figure 45. REG TUBE RECT panel, front view with cover removed.

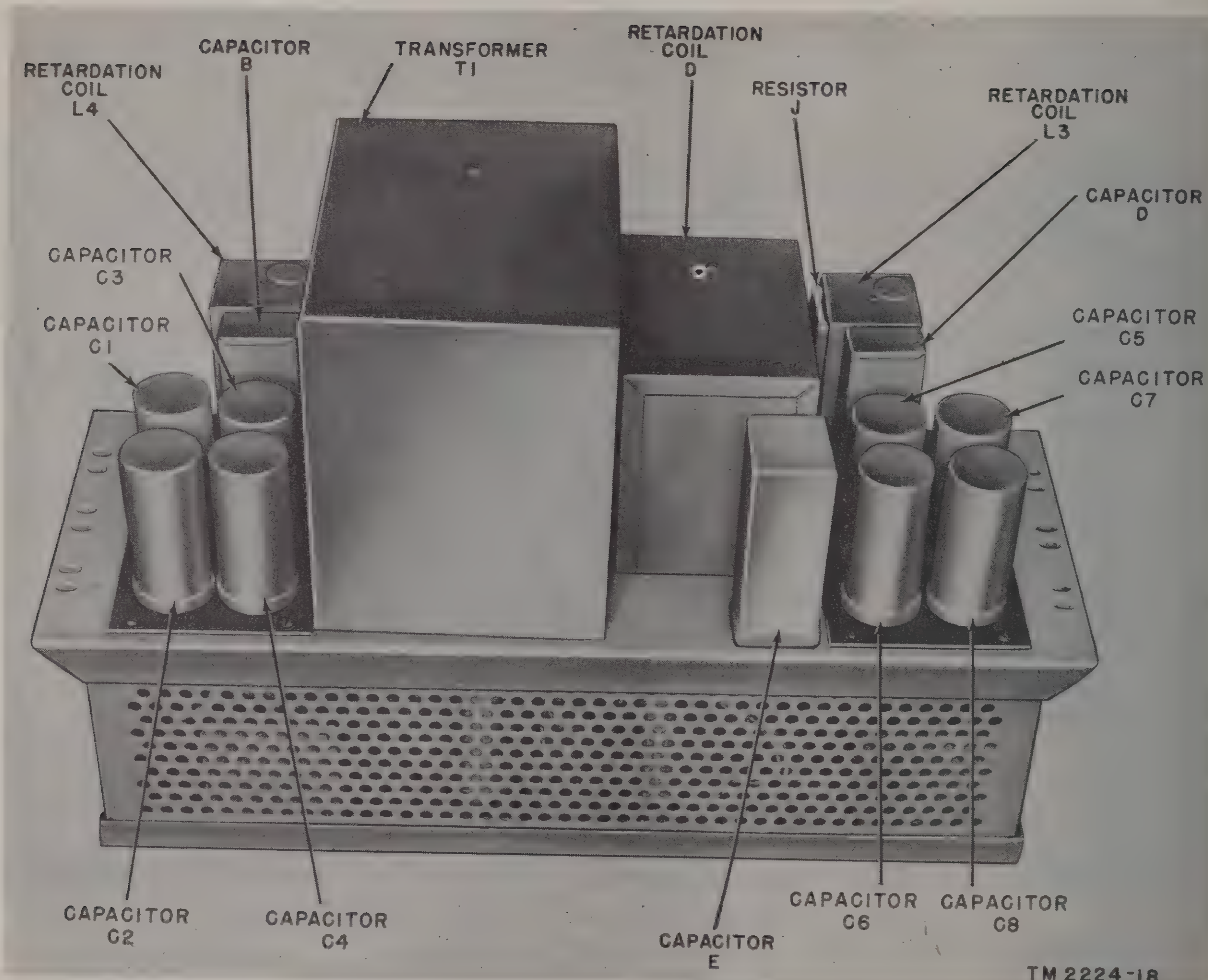

Figure 46. *REG TUBE RECT panel, rear view.*

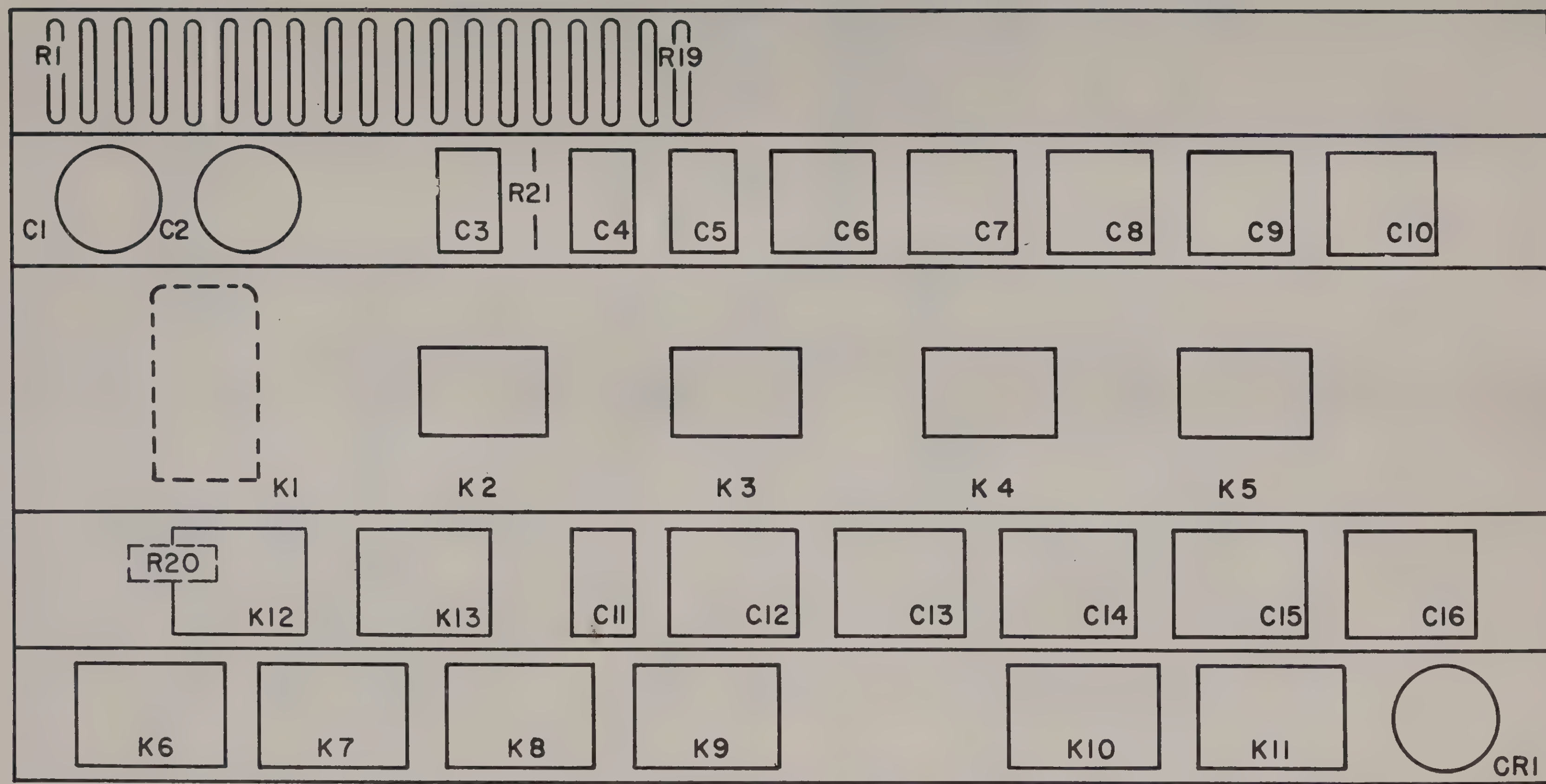

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Figure 47. COMP CKT panel, front view.

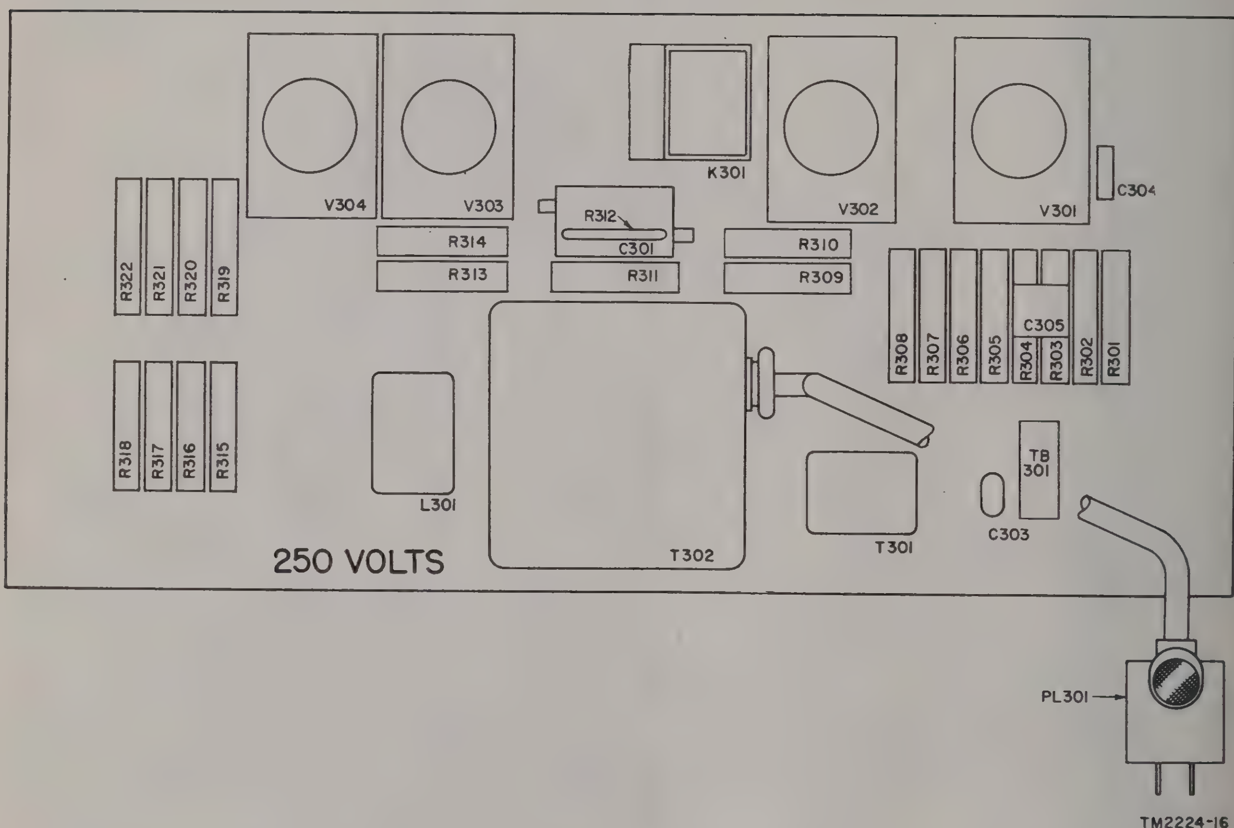


Figure 48. RECT PEAK VM panel, rear view with radiation shield removed.

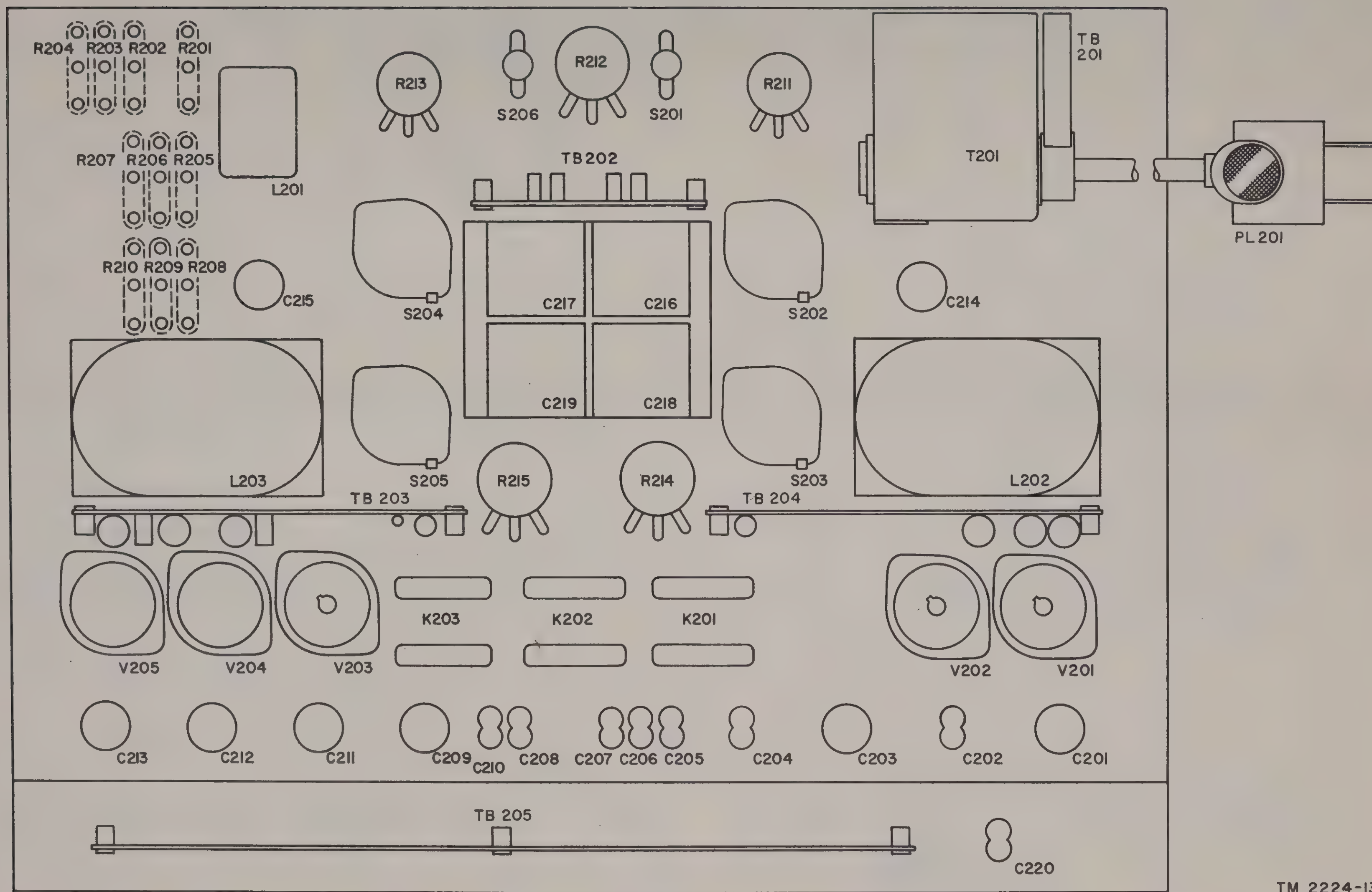


Figure 49. DISTRIBUTOR panel, rear view.

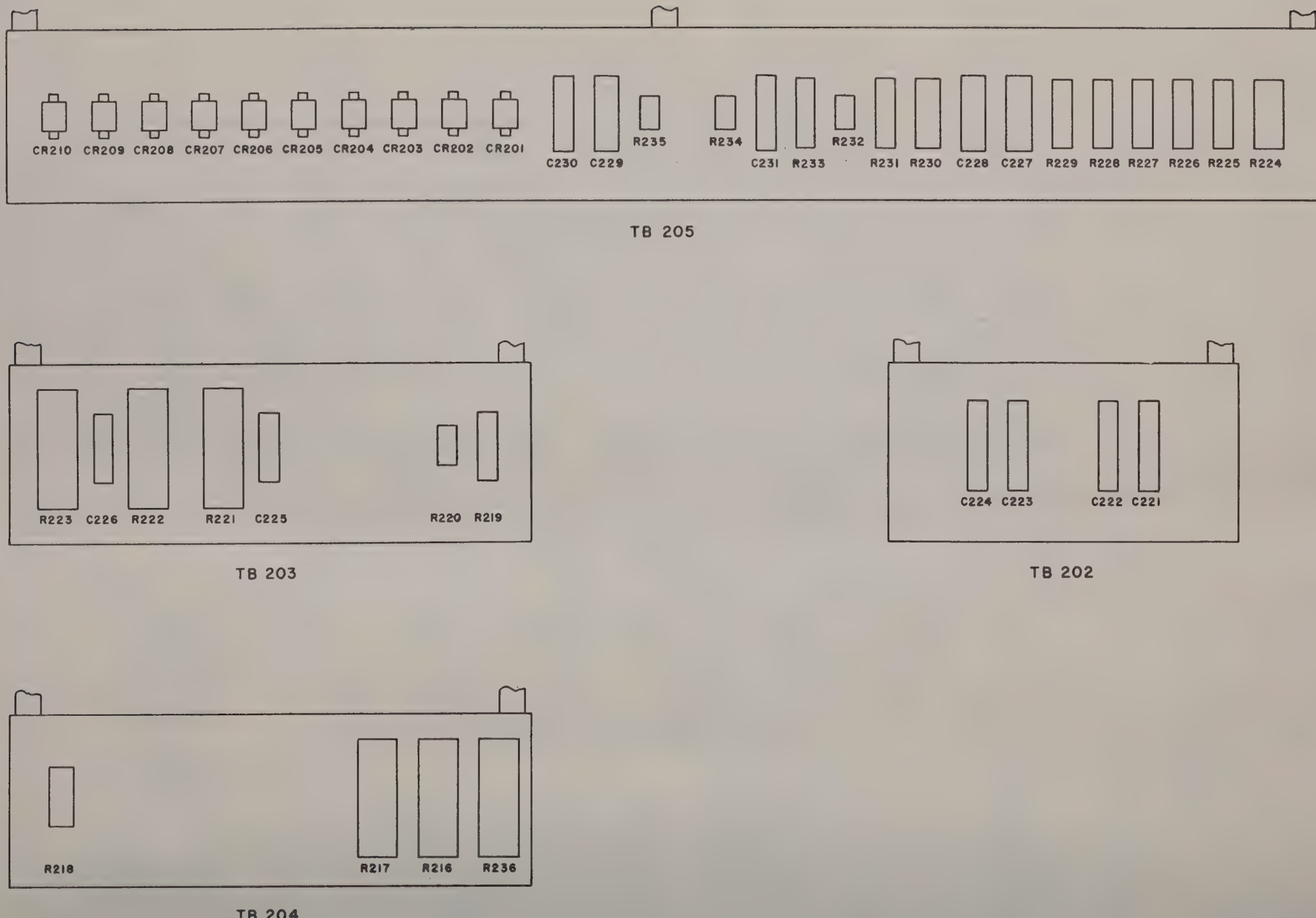


Figure 50. DISTRIBUTOR panel, terminal boards.

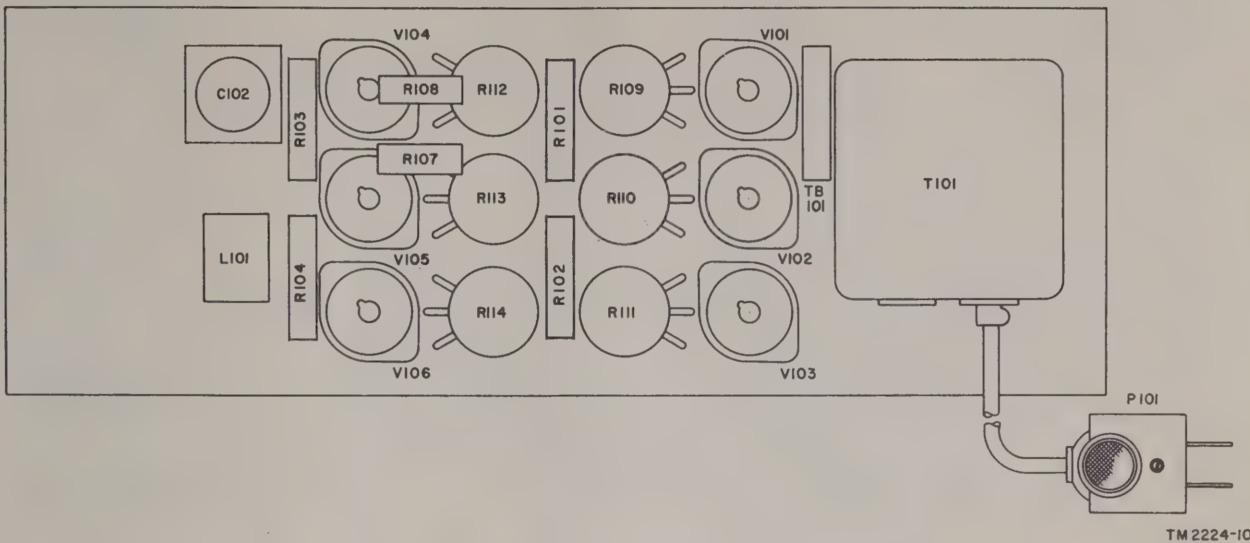


Figure 51. PWR SUP panel, rear view.

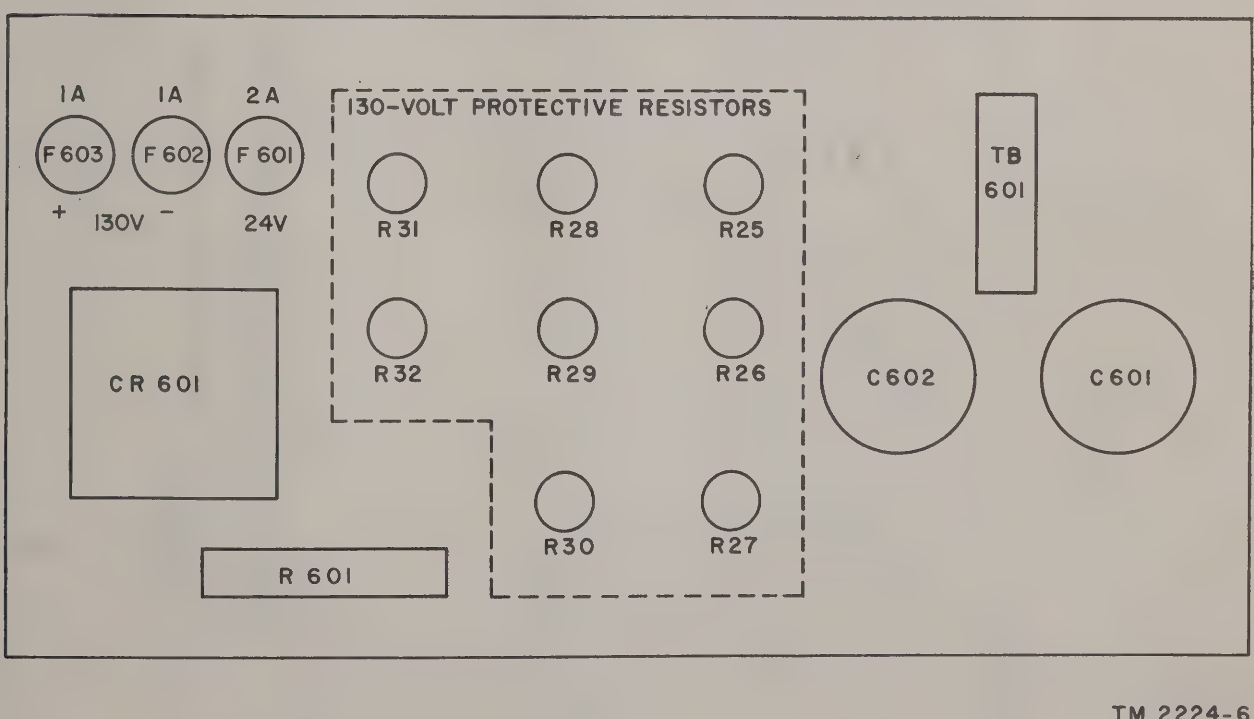
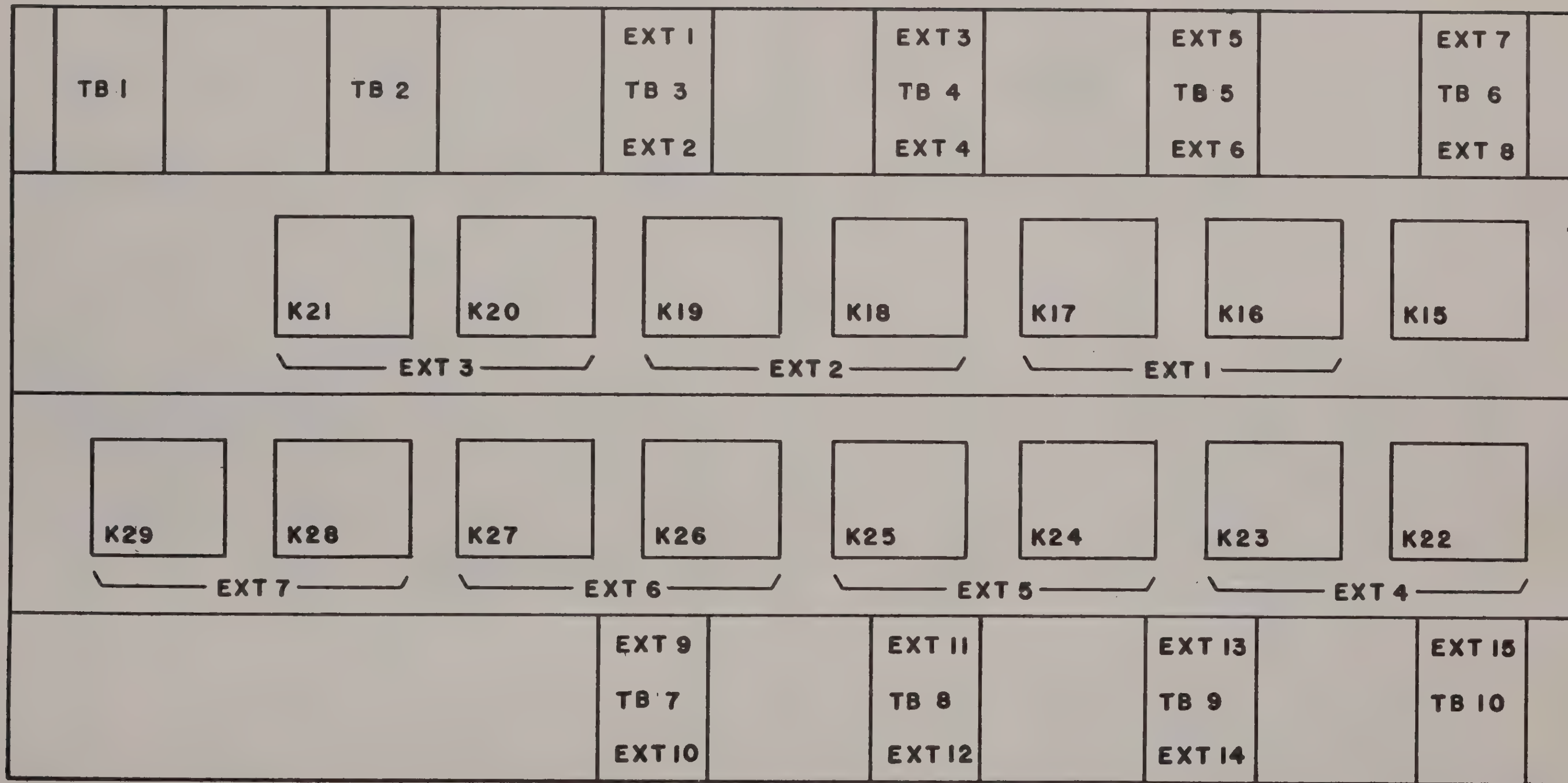


Figure 52. 24 VOLT SUP panel, rear view.



NOTES: 1. TERMINAL BOARDS 1 TO 5 ARE MOUNTED BEHIND RELAYS K16 TO K22 BUT ARE SHOWN HERE SEPARATELY FOR SIMPLICITY.
2. ONLY WIRING IS SUPPLIED FOR EXTENSIONS 8 THROUGH 15.

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Figure 53. EXT CKT panels, rear view.

the two screws on the cover and slide the cover off the box. Transformer terminals may be inspected or soldered with the cover removed. To replace the transformer, remove the entire box. Two screws secure the box in place.

d. If a rotary switch is to be replaced, carefully tag each lead to be removed. This will avoid misconnection when the new switch is being installed. Follow this practice whenever replacement requires the disconnection of several wires.

e. All control knobs are secured by setscrews. To remove a knob, use either a wrench or a screwdriver to loosen the setscrew. Some of the shafts for the knobs are round and the knobs must be replaced in the identical position. Make a note of the position before removing the knob.

f. When soldering, follow the instructions as contained in TB SIG 222, Solder and Soldering.

g. Instructions for refinishing badly marred panels on exterior cabinets are given in TM 9–2851, Painting Instructions for Field Use.

122. Adjustments of Relays and Switches

The relays and switches used in the teletypewriter test set are adjustable. General instructions for adjustment procedures appear in TM 11–4302, Tactical Switchboards and Long Lines Equipment; Repair Instructions, Apparatus Requirements. The relay adjustment table in this paragraph gives the *specific* test connection requirements for the relays used in the teletypewriter test set. Figure 54 shows the various types of spring combinations used on the relays. Be careful when adjusting relays. Carelessness may result in damage to the relays.

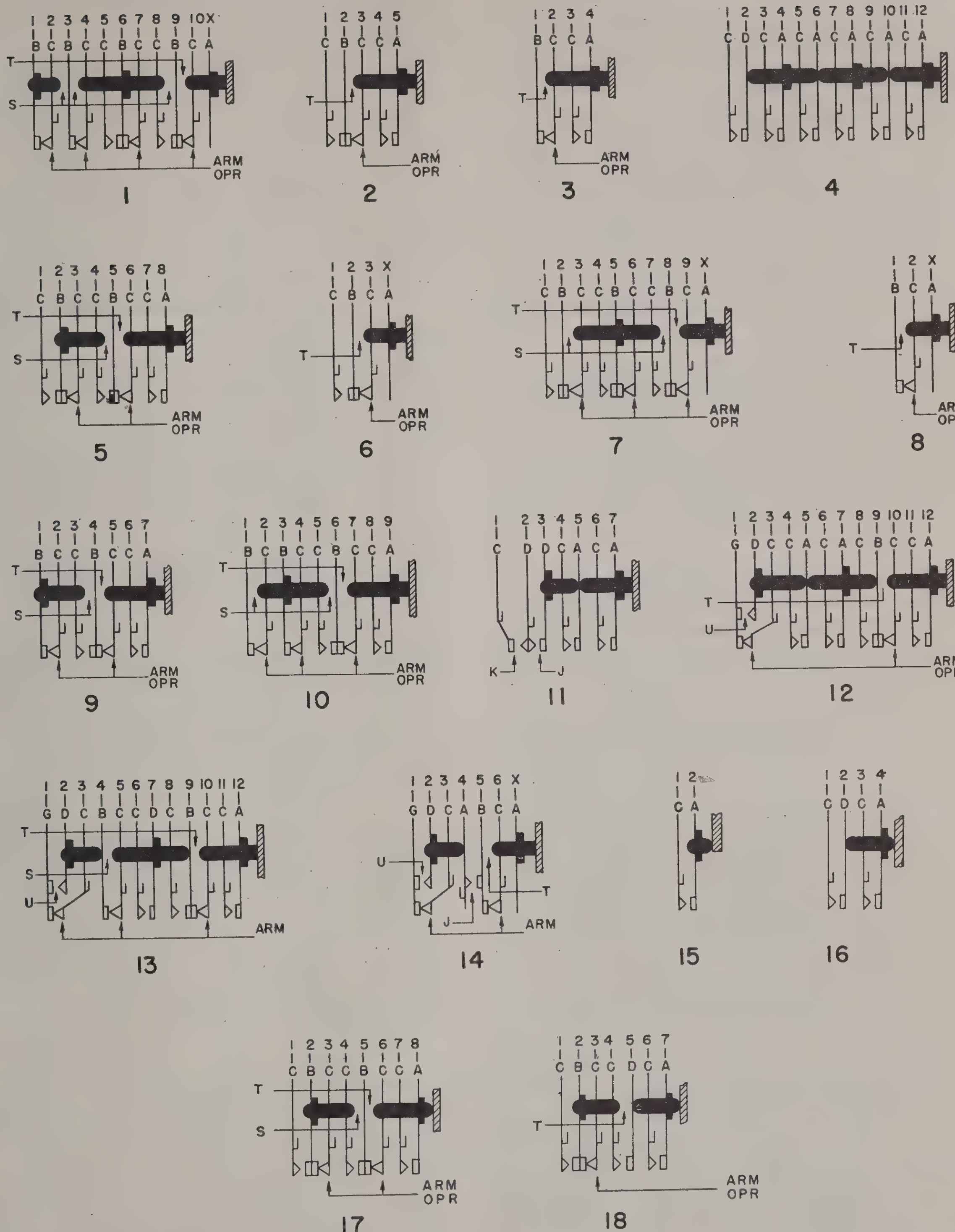
Relay adjustment table

Relay reference symbols	Applicable spring combination (fig. 54)	Circuit preparation. Use test clip to connect			Plug at TMS IN jack of teletypewriter test set	Dc fuses on REG TUBE RECT +TG and REG TUBE RECT −TG panels	Dc current requirements				Remarks
		Battery to—	Ground to—	Indicated power supply to test set ground			Test for	Arm. travel (in.)	Ma		
									Test	Readjust	
K6	4 (2 ea)		K6	−130 v	Insert	Insert	Operate	0.029	20.5	19.5	
K7	10, 9	K7		24 v	Insert	Remove	Operate	.047	21.0	20.0	Block relay K12 in operated position ADJ SPD switch in nonoperated position.
K8	3, 8	K8		24 v	Remove	Remove	Operate	.035	11.3	10.7	
K9	6 (2 ea)	K9		24 v	Remove	Remove	Operate	.047	17.5	16.5	
K10	14 (2 ea)	K10		24 v	Remove	Remove	Operate	.071	47.5	45	
K11	13, 12		K11	−130 v	Remove	Remove	Operate	.059	39.5	37.5	
K16[1]	13, 12		K16	−130 v	Remove	Remove	Operate	.059	39.5	37.5	
K15[2]	6 (2 ea)	K15		+130 v	Insert	Insert	Operate	.047	17.5	16.5	
K17[3]	16 (2 ea)	K17		−130 v	Remove	Insert	Operate	.029	5.7	5.4	
K12	2 (2 ea)	K12		24 v	Remove	Remove	Operate	.047	17.5	16.5	
K13	16, 15	K13		24 v	Remove	Insert	Operate	.029	9.5	8.9	
K201	5, 11		K201	−130 v	Insert	Remove	Operate	.050	20.0	19.0	Operate SPEED 75–100 switch to 100.
K202	1, 7	K202		24 v	Insert	Remove	Operate	.059	37	35	
K203	7, 5		K203	−130 v	Insert	Remove	Operate	.059	33	31	Operate SPEED 75–100 switch to 100.
K204	6 (2 ea)	K204		−130 v	Remove	Insert	Operate	.047	17.5	16.5	

[1]To adjust even-numbered relays K16 through K44, remove the plug from the TMS IN jack at the extension unit.

[2]To adjust relay K15, insert the plug into the TMS IN jack at the extension unit.

[3]To adjust odd-numbered relays K17 through K45, remove the plug from the TMS IN jack at the extension unit.



NOTE:
FOR EXPLANATION OF SYMBOLS USED ON THIS DRAWING,
REFER TO RELAY MAINTENANCE INFORMATION IN THIS MANUAL.

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Figure 54. Relay spring combinations.

123. Adjustment of U-Type Relays

a. Armature Travel. Armature travel is equal to the gap between the armature and the armature stop when the armature is resting against the adjusting nut.

(1) Adjust the armature travel to the value specified for the given relay in the *Armature travel* column of the relay adjustment table (par. 122).

(2) Check the armature travel with a thickness gage.

(3) Unless otherwise specified, all tolerances are .003 inch. This tolerance applies to all armature travel values given in the relay adjustment table unless the value is designated maximum travel. To check the armature travel requirement on relays, insert a gage 0.003 inch larger than the specified gap. If the gage enters, it should enter with a tight fit. Do not force the gage.

b. Spring-Tension Measurements.

(1) *General.* All springs are tensioned towards the armature. Unless the abbreviation ARM OPR (armature operated) is shown with an arrow mark leading to a spring (fig. 54), the tension is measured with the armature in the nonoperated position. Use a spring-tension gage to check the tension. Apply the gage so that the tip of the gage engages both prongs of the bifurcated springs. (Bifurcated springs are those that have two parts at the tip of the spring.) When gaging tensions on solid springs, apply the tip of the gage to the front end of the spring just in front of the contacts. The correct tension of a spring that is tensioned against a spool head is obtained by noting the spring-tension gage indication at the moment when the tang of the spring leaves the spool head. The correct tension of a spring, whose contacts are tensioned against the contacts of an opposing spring, is obtained by noting the spring-tension gage indication at the moment the contacts break. The correct tension of a spring that is tensioned against a stud is obtained by noting the spring-tension gage indication at the moment the spring leaves the stud.

(2) *A-Type springs.*

(*a*) Springs designated by the letter A (fig. 54) have no definite tension, but are tensioned toward the armature. When A-type springs are tensioned against the armature, either directly or indirectly through studs, their tension together with the tension of any D-type springs ((5) below) should hold the armature against the adjusting nut with sufficient pressure to insure that the requirement given in *c* below is met.

(*b*) When spring-type hinges are used, the combined tension in the top spring combination should be approximately equal to the tension in the bottom spring combination. When pin-type hinges are used, tension in one spring combination should be approximately equal to (but no more than) two and a half times the tension of the other spring combination. To check the stud pressure on these relays, block the armature in its nonoperated position with an armature blocking tool. Check the pressure of the stud against the armature by applying a spring-tension gage to the spring nearest the armature. In the No. 4, 6, or 10 spring combination (fig. 54), no stud gap should be present on either side of spring 5 or between spring 9 and the stud on the spring 8; when a D spring is present, it should be lifted off its associated stud.

(3) *B-type springs.* When the letter B appears with a particular spring (for example, spring 9 in the No. 10 spring combination of fig. 54), this spring, together with any other springs tensioned against it, should have a combined tension of 18 grams (test-minimum), 20 grams (readjust-minimum). Check with a spring-tension gage on the B spring.

(4) *C-type springs.* When the letter C appears with a particular spring (fig. 54), this spring, together with any

other springs tensioned against it, should have a combined spring tension of 25 grams (test-minimum), 30 grams (readjust-minimum). Check with a spring-tension gage.

(5) *D-type springs.* When the letter D appears with a particular spring (fig. 54), this spring, together with any other springs tensioned against it, should have a combined spring tension of 5 grams (test-minimum); 6 grams (readjust-minimum). Check with a spring-tension gage.

(6) *G-type springs.* When the letter G appears with a particular spring (fig. 54), this spring, together with any other springs tensioned against it, should have a combined spring tension of 35 grams (test-minimum), 40 grams (readjust-minimum). Check with a spring-tension gage.

c. Armature Back Tension. The armature is held against the adjusting nut with a pressure of 18 grams (test-minimum), 22 grams (readjust-minimum). Apply a spring-tension gage to the back of the armature at a point approximately midway between the points where the stop disks normally are located.

d. Spring Stud Clearance. The spring studs must clear the springs through which they pass in all positions of armature travel; check visually.

e. Straightness of Springs. All springs other than pretensioned springs, must be free of sharp bends or kinks caused by adjustment except for thin (.013-inch or .018-inch) springs. In thin springs, a kink is permitted provided it is within one-fourth inch of the point where the spring leaves the insulators. A gradual bow in a spring is permissible; check visually.

f. Stud Gap.

(1) *Stud gaps designated T.* For non-operated relays, the clearance between the stud and the spring at the points designated T (fig. 54) must be a minimum of 0.006 inch. This requirement is met if there is a clearance between the spring and the stud when a thickness gage is inserted between the armature and the end of of the stud that rests against the armature. Check visually; use a test lamp to illuminate the stud gap. Do not attempt to check the stud gaps by moving the armature toward the core manually; when the armature is released, it may not restore to its position against the front ends of the yoke. This causes false contact operation. To check the stud gaps, use the test lamp to illuminate the gap on the side away from the eye and sight through the stud gap toward the light.

(2) *Stud gaps designated S.* For non-operated relays, there must be a slight clearance between the spring studs and the spring at the points designated S (fig. 54); check visually.

g. Contact Make and Alinement.

(1) On a bifurcated spring, *both* contacts must make with the contacts on its associated spring. Aline all sets of contacts properly.

(2) When a thickness gage is inserted in the armature gap and the relay is energized, normally open contacts should meet the requirements indicated in the following chart:

Contact type	Gage thickness (contacts should not make)	Gage thickness (at least one pair of contacts make)
All contact types except those designated J, K, or U.	0.018 inch gage for test	0.008 inch gage for test.
	0.015 inch gage for readjustment	0.010 inch gage for readjustment.
Contacts designated K	No requirements	0.013 inch gage for test. 0.015 inch gage for readjustment.
Contacts designated J or U	No requirements	Test and readjustment not required.

(3) The requirements in the chart ((2) above) are met if at least one pair of contacts close when the relay is energized electrically against an 0.008 inch thickness gage on the specified test or readjust current. Operate the relay electrically. Release the relay and insert a gage of the proper thickness in

the armature gap. Energize the relay and note whether the contacts close. If the contacts do not close, readjust the relay.

(4) After a contact has been cleaned or a spring buildup removed, or after readjustments have been made on a spring, the affected contacts must meet the following requirements in addition to those listed in (2) above.

(*a*) For normally open contacts, both contacts on the bifurcated spring should make when the relay is energized against a 0.004 inch thickness gage.

(*b*) For normally closed contacts, both contacts on the bifurcated spring should break from their associated contacts at approximately the same time. Operate the relay manually and check visually.

h. Contact Separation.

(1) *All contacts except those designated U.* The separation between each pair of contacts, normally open, or between each pair of contacts that are opened when the relay is operated electrically, should be a minimum of 0.005 inch. On normally closed contacts, the requirement is met if the contacts break when the relay is energized electrically with a 0.004 inch thickness gage inserted in the armature gap. To check contact separation of pitted, normally closed contacts, move the spool-head spring, manually, toward its associated spring. A perceptible movement of the spring (at least 0.005 inch) before the contacts make indicates a satisfactory minimum contact separation.

(2) *Contacts designated U.* The contact separation of the normally open contacts designated U should be a minimum of 0.010 inch when measured with a thickness gage.

i. Contact Sequence. The normally closed contacts, of any break-make or break-make-make spring combination, should break before the normally open contacts make.

124. Adjustment of Polar Relays (K2 Through K5)

Use Test Set I–193–A to test and adjust polar relays. TM 11–2513, Test Sets I–193–A, I–193–B, and I–193–C, contains test and adjustment information.

125. Adjustment of Relay K301.

a. Tightness of Assembly.

(1) Check to see that the spring assemblies are fastened securely to the armature.

(2) Check to see that the armature back stops are fastened securely to the brass yoke at the base of the core.

b. Contact Surfaces. Clean contact surfaces and remove burrs.

c. Contact Alinement. Aline each set of contacts so that when contacts are closed completely, the outer edge of one contact (the smaller, if different sizes) does not overlap the outer edge of the other contact by more than one-sixteenth inch; check visually.

d. Contact Gap. Adjust minimum contact gap to three-sixteenths of an inch. Use a thickness gage.

e. Contact Sequence. Visually check the following adjustments:

(1) Adjust all normally open contacts to make and break simultaneously.

(2) Adjust all normally closed contacts to break and make simultaneously.

f. Contact Pressure. Adjust the minimum contact pressure to 60 grams.

g. Relay Mounting. Check to see that the relay is securely mounted.

h. Electrical Requirements. The relay must operate when 24 volts dc is applied to the coil terminals.

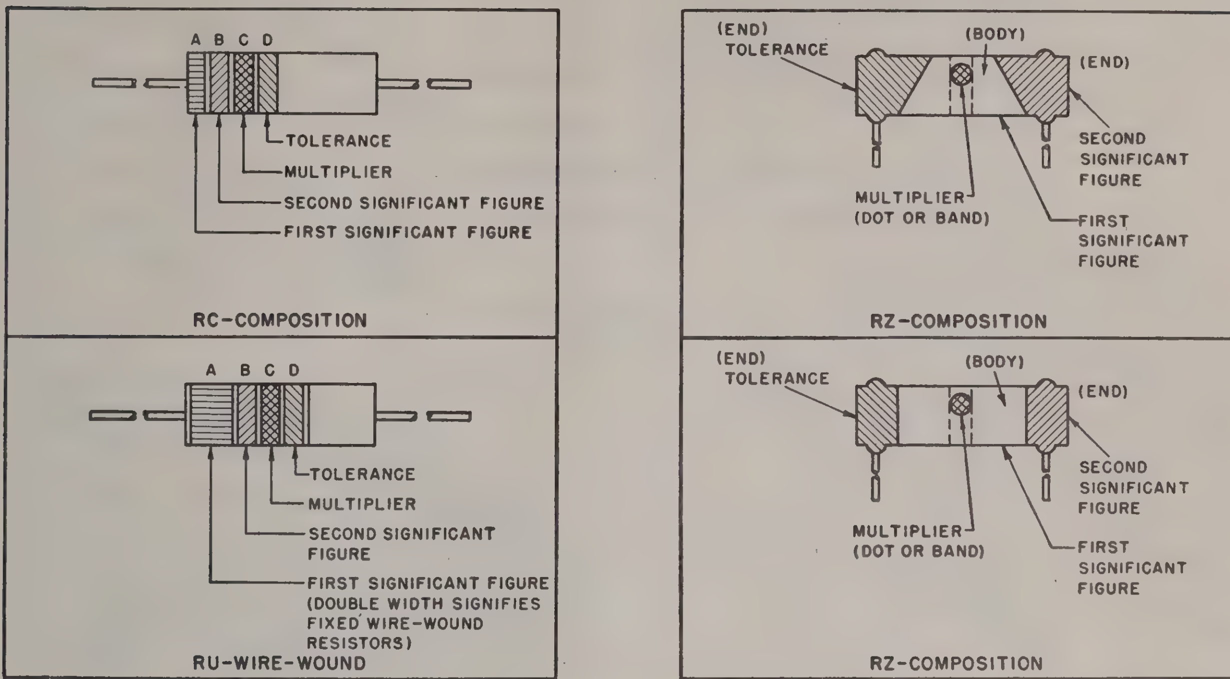
126. Relay K1

Relay K1 is not adjustable. To check the relay, substitute another relay K1, known to be in good working condition. If this clears the trouble, relay K1 that is removed should be discarded.

Caution: Do not allow the relay to tilt during removal. The aligning plug in the center of the base may be broken off. Do not attempt to remove the relay from the socket by pulling on the metal envelope. The envelope may come loose from the relay base. Use a tube puller. Relay K1 is hermetically sealed under great pressure; do not drill into it, hammer on it, or burn it.

RESISTOR COLOR CODE MARKING
(MIL-STD RESISTORS)

AXIAL-LEAD RESISTORS (INSULATED) | **RADIAL-LEAD RESISTORS (UNINSULATED)**



RESISTOR COLOR CODE

BAND A OR BODY*		BAND B OR END*		BAND C OR DOT OR BAND*		BAND D OR END*	
COLOR	FIRST SIGNIFICANT FIGURE	COLOR	SECOND SIGNIFICANT FIGURE	COLOR	MULTIPLIER	COLOR	RESISTANCE TOLERANCE (PERCENT)
BLACK	0	BLACK	0	BLACK	1	BODY	± 20
BROWN	1	BROWN	1	BROWN	10	SILVER	± 10
RED	2	RED	2	RED	100	GOLD	± 5
ORANGE	3	ORANGE	3	ORANGE	1,000		
YELLOW	4	YELLOW	4	YELLOW	10,000		
GREEN	5	GREEN	5	GREEN	100,000		
BLUE	6	BLUE	6	BLUE	1,000,000		
PURPLE (VIOLET)	7	PURPLE (VIOLET)	7				
GRAY	8	GRAY	8	GOLD	0.1		
WHITE	9	WHITE	9	SILVER	0.01		

*FOR WIRE-WOUND-TYPE RESISTORS, BAND A SHALL BE DOUBLE-WIDTH. WHEN BODY COLOR IS THE SAME AS THE DOT (OR BAND) OR END COLOR, THE COLORS ARE DIFFERENTIATED BY SHADE, GLOSS, OR OTHER MEANS.

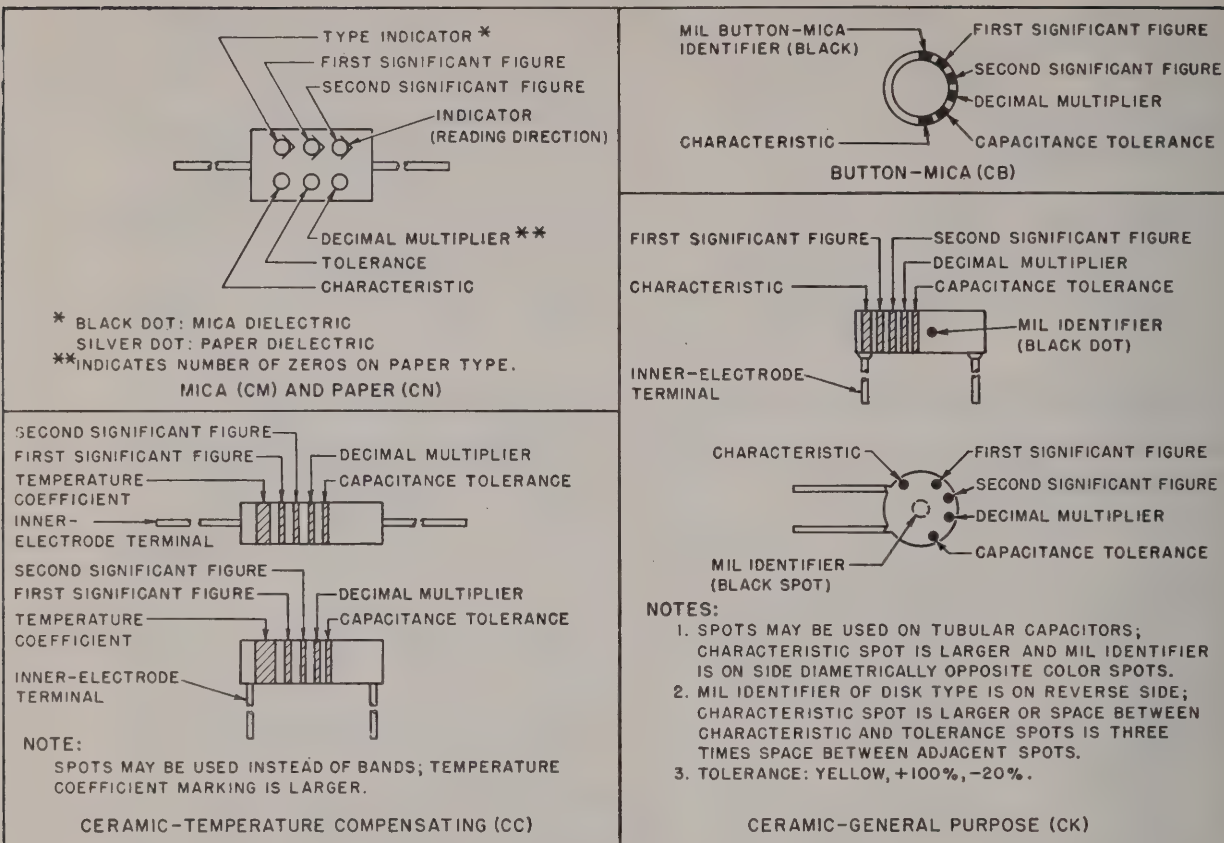
EXAMPLES (BAND MARKING):
10 OHMS ±20 PERCENT: BROWN BAND A; BLACK BAND B; BLACK BAND C; NO BAND D.
4.7 OHMS ±5 PERCENT: YELLOW BAND A; PURPLE BAND B; GOLD BAND C; GOLD BAND D.

EXAMPLES (BODY MARKING):
10 OHMS ±20 PERCENT: BROWN BODY; BLACK END; BLACK DOT OR BAND; BODY COLOR ON TOLERANCE END.
3,000 OHMS ±10 PERCENT: ORANGE BODY; BLACK END; RED DOT OR BAND; SILVER END.

STD-R1

Figure 55. MIL–STD resistor codes.

CAPACITOR COLOR CODE MARKING
(MIL-STD CAPACITORS)



CAPACITOR COLOR CODE

COLOR	SIG FIG.	MULTIPLIER		CHARACTERISTIC[1]				TOLERANCE[2]					TEMPERATURE COEFFICIENT (UUF/UF/°C)
		DECIMAL	NUMBER OF ZEROS	CM	CN	CB	CK	CM	CN	CB	CC		CC
											OVER 10UUF	10UUF OR LESS	
BLACK	0	1	NONE		A			20	20	20	20	2	ZERO
BROWN	1	10	1	B	E	B	W				1		-30
RED	2	100	2	C	H		X	2		2	2		-80
ORANGE	3	1,000	3	D	J	D			30				-150
YELLOW	4	10,000	4	E	P								-220
GREEN	5		5	F	R						5	0.5	-330
BLUE	6		6		S								-470
PURPLE (VIOLET)	7		7		T	W							-750
GRAY	8		8			X						0.25	+30
WHITE	9		9								10	1	-330(±500)[3]
GOLD		0.1						5		5			+100
SILVER		0.01						10	10	10			

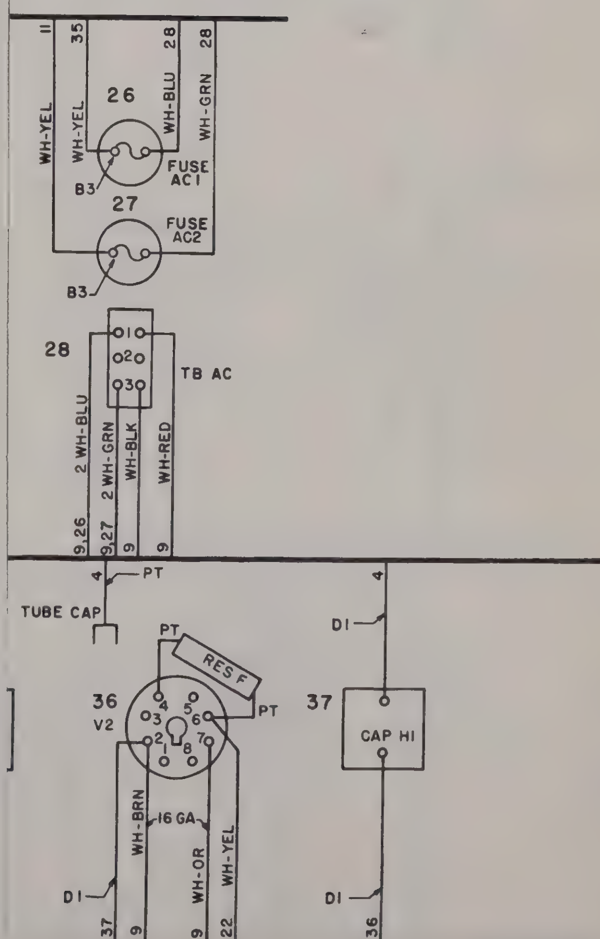
1. LETTERS ARE IN TYPE DESIGNATIONS GIVEN IN MIL-C SPECIFICATIONS.
2. IN PERCENT, EXCEPT IN UUF FOR CC-TYPE CAPACITORS OF 10 UUF OR LESS.
3. INTENDED FOR USE IN CIRCUITS NOT REQUIRING COMPENSATION.

STD-C1

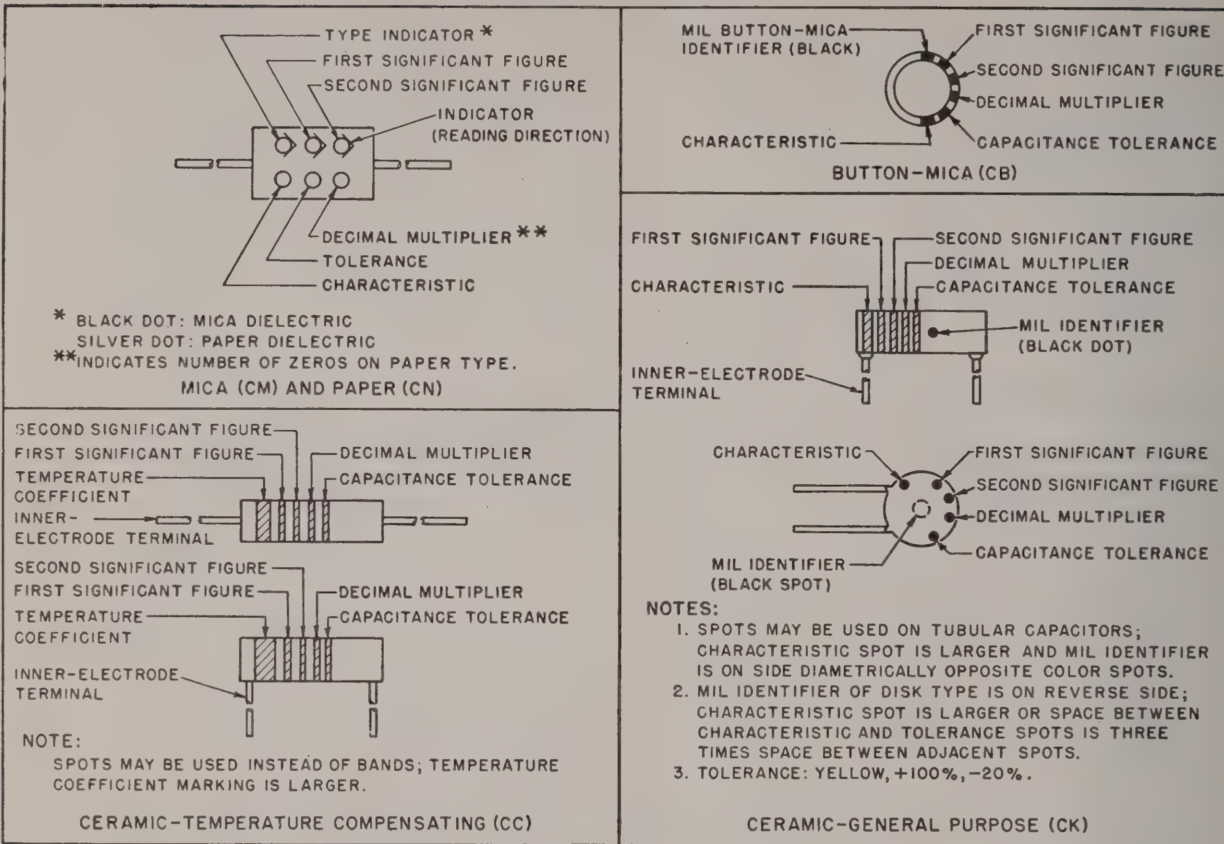
Figure 56. MIL–STD resistor codes.

RESISTANCE STAMPED ON THERMISTOR T.
UNLESS OTHERWISE SPECIFIED, LEADS ARE 20 GA STRANDED WIRE; 16 GA WIRE IS STRANDED.

SYMBOL	EXPLANATION
DI	WIRING RUN IN THE SHORTEST POSSIBLE MANNER.
PT	LEADS ARE PART OF THE APPARATUS
BI	BOTTOM EDGE OF A TERMINAL BOARD.
B2	TERMINAL NEAREST TO PANEL.
B3	TERMINAL ON THE SIDE OF THE FUSE SOCKET.
KI	LEFT SIDE OF TERMINAL BOARD.



CAPACITOR COLOR CODE MARKING
(MIL-STD CAPACITORS)



CAPACITOR COLOR CODE

COLOR	SIG FIG.	MULTIPLIER		CHARACTERISTIC[1]				TOLERANCE[2]					TEMPERATURE COEFFICIENT (UUF/UF/°C)
		DECIMAL	NUMBER OF ZEROS	CM	CN	CB	CK	CM	CN	CB	CC OVER 10UUF	CC 10UUF OR LESS	CC
BLACK	0	1	NONE		A			20	20	20	20	2	ZERO
BROWN	1	10	1	B	E	B	W				1		−30
RED	2	100	2	C	H		X	2		2	2		−80
ORANGE	3	1,000	3	D	J	D			30				−150
YELLOW	4	10,000	4	E	P								−220
GREEN	5		5	F	R						5	0.5	−330
BLUE	6		6		S								−470
PURPLE (VIOLET)	7		7		T	W							−750
GRAY	8		8			X						0.25	+30
WHITE	9		9								10	1	−330(±500)[3]
GOLD		0.1						5		5			+100
SILVER		0.01						10	10	10			

1. LETTERS ARE IN TYPE DESIGNATIONS GIVEN IN MIL-C SPECIFICATIONS.
2. IN PERCENT, EXCEPT IN UUF FOR CC-TYPE CAPACITORS OF 10 UUF OR LESS.
3. INTENDED FOR USE IN CIRCUITS NOT REQUIRING COMPENSATION.

STD-C1

Figure 56. MIL–STD resistor codes.

NOTES:

1. TERMINAL 2 OF TERMINAL BOARD TB B IS WIRED TO TERMINAL 1 OF TERMINAL BOARD TB 601. REFER TO THE STATION 3 OF THE 24 VOLT SUPPLY CIRCUIT WIRING DIAGRAM.
2. TERMINAL 6 OF TERMINAL BOARD TB B ON THE REG TUBE RECT +TG PANEL IS WIRED TO TERMINAL 2 OF TB B ON THE REC TUBE RECT -TG PANEL. REFER TO STATION 5 OF THE REG TUBE RECT -TG PANEL WIRING DIAGRAM.
3. TERMINAL 7 OF TERMINAL BOARD TB B IS WIRED TO FUSE F603. REFER TO STATION 121 ON THE COMPARISON CIRCUIT WIRING DIAGRAM.
4. TERMINAL 8 OF TERMINAL BOARD TB B ON THE REG TUBE RECT +TG PANEL IS WIRED TO TERMINAL 8 OF TERMINAL BOARD TB B ON THE REG TUBE RECT -TG PANEL. REFER TO THE REG TUBE RECT -TG PANEL WIRING DIAGRAM.
5. A TERMINAL-ON RESISTOR C HAS BEEN FACTORY SELECTED SO THAT ITS RESISTANCE IS EQUAL TO THE TOTAL RESISTANCE STAMPED ON THERMISTOR T.
6. UNLESS OTHERWISE SPECIFIED, LEADS ARE 20 GA STRANDED WIRE; 16 GA WIRE IS STRANDED.
7.

SYMBOL	EXPLANATION
DI	WIRING RUN IN THE SHORTEST POSSIBLE MANNER.
PT	LEADS ARE PART OF THE APPARATUS
BI	BOTTOM EDGE OF A TERMINAL BOARD.
B2	TERMINAL NEAREST TO PANEL.
B3	TERMINAL ON THE SIDE OF THE FUSE SOCKET.
KI	LEFT SIDE OF TERMINAL BOARD.

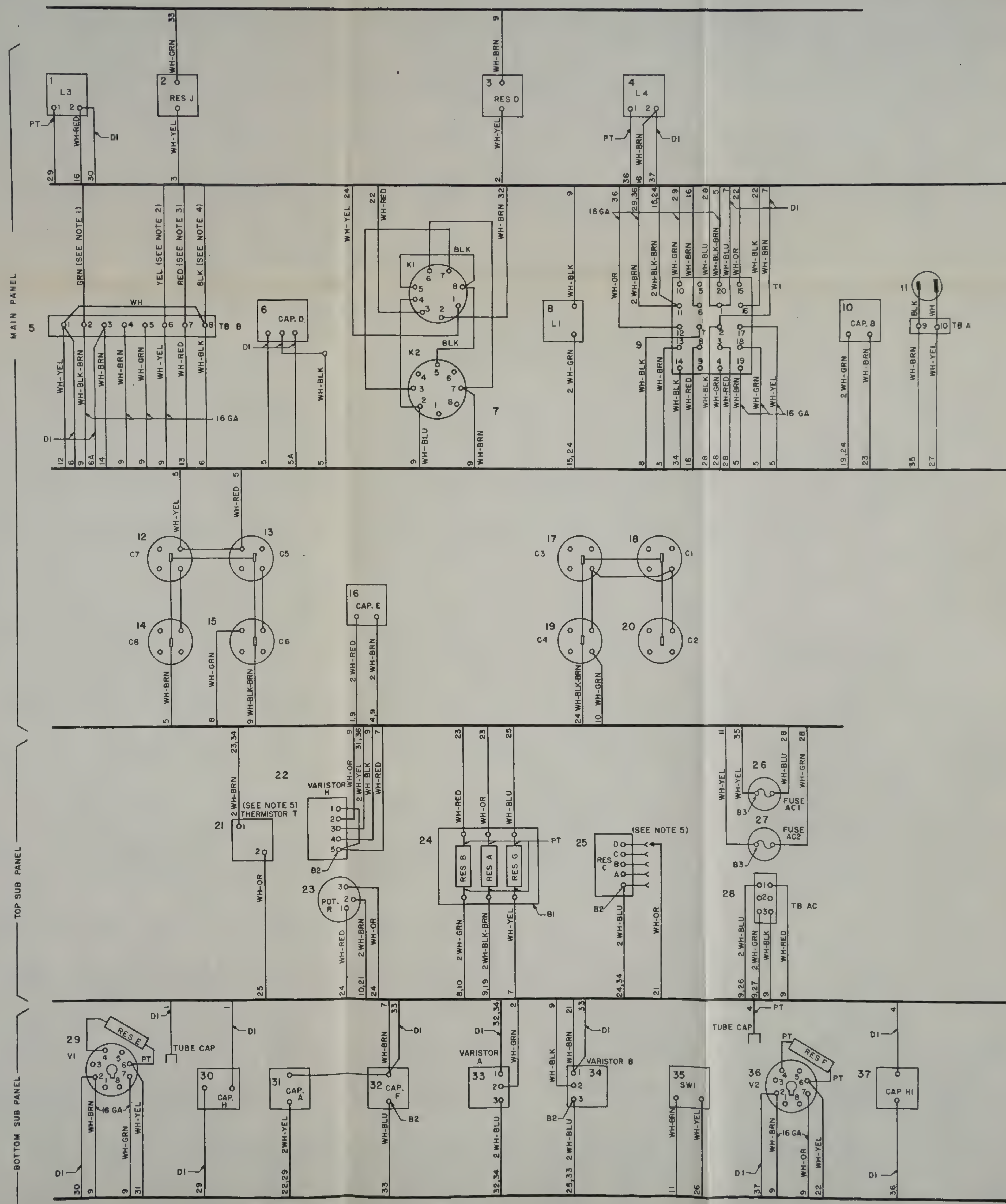
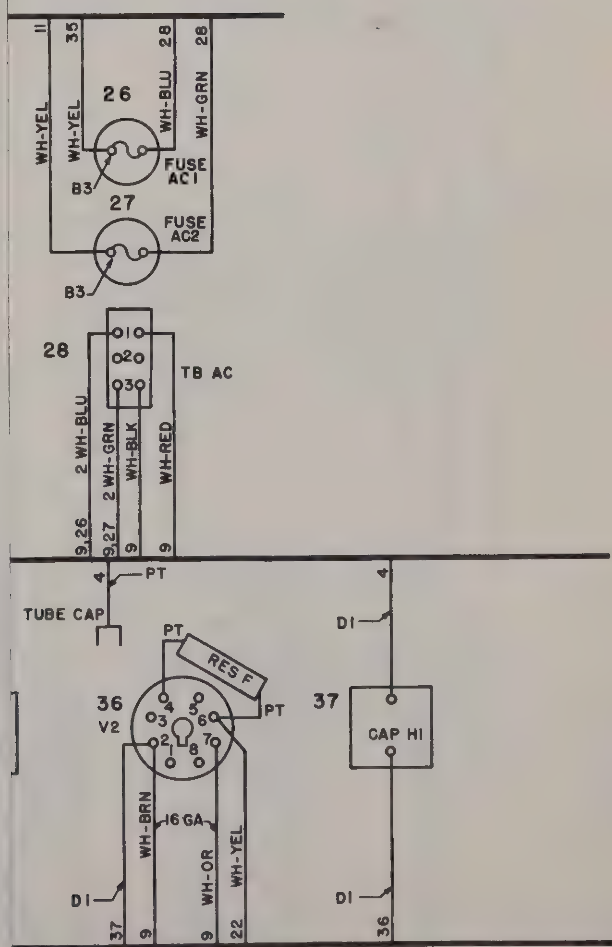


Figure 57. REG TUBE RECT+TG panel, wiring diagram.

F
W
A
SC
RE...
UNLESS OTHERWISE SPECIFIED, LEADS ARE 20 GA STRANDED WIRE; 16 GA WIRE IS STRANDED.

SYMBOL	EXPLANATION
DI	WIRING RUN IN THE SHORTEST POSSIBLE MANNER.
PT	LEADS ARE PART OF THE APPARATUS.
BI	BOTTOM EDGE OF A TERMINAL BOARD.
B2	TERMINAL NEAREST TO PANEL.
B3	TERMINAL ON THE SIDE OF THE FUSE SOCKET.
KI	LEFT SIDE OF TERMINAL BOARD.



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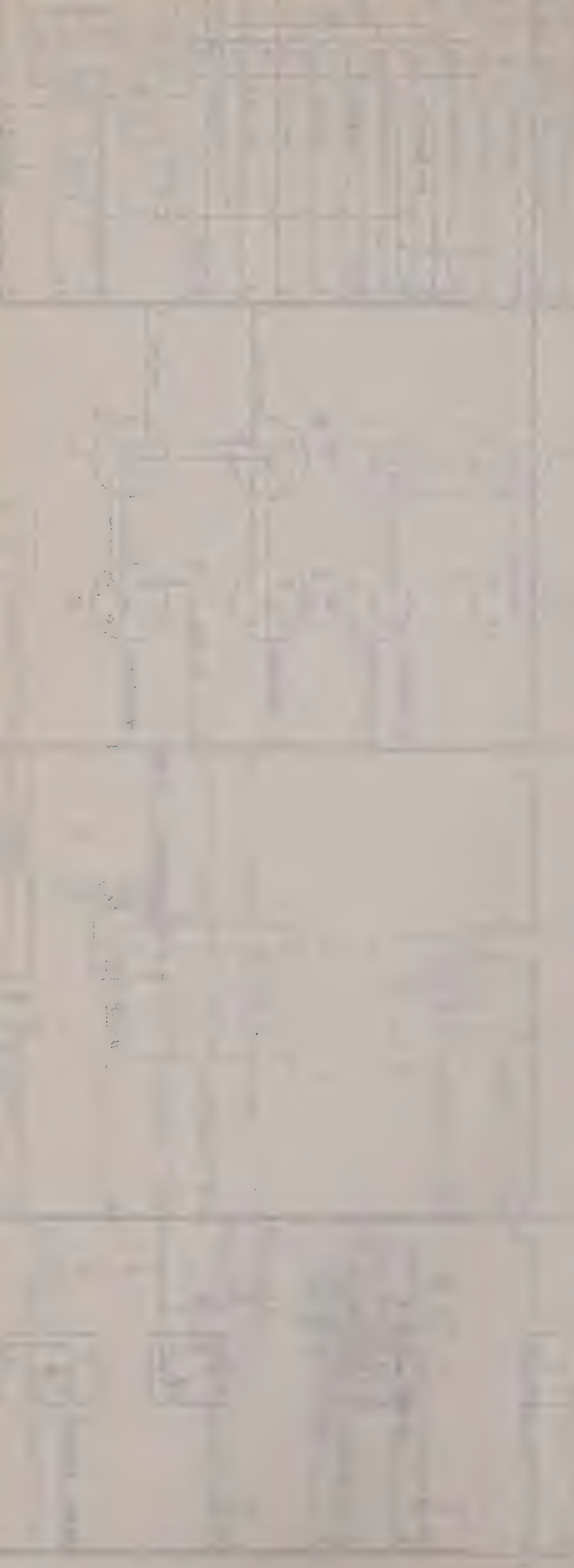


NOTES:

1. TERMINAL 2 OF TERMINAL BOARD TB B ON THE REG TUBE RECT-TG PANEL IS WIRED TO TERMINAL 6 OF TERMINAL BOARD TB B ON THE REG TUBE RECT + TG PANEL. REFER TO STATION 5 OF THE REG TUBE RECT + TG PANEL WIRING DIAGRAM.
2. TERMINAL 6 OF TERMINAL BOARD TB B IS WIRED TO TERMINAL 2 ON TERMINAL BOARD TB601 REFER TO STATION 3 ON THE 24 VOLT SUPPLY CIRCUIT WIRING DIAGRAM.
3. TERMINAL 7 OF TERMINAL BOARD TB B IS WIRED TO FUSE F602. REFER TO STATION 122 ON THE COMPARISON CIRCUIT WIRING DIAGRAM.
4. TERMINAL 8 OF TERMINAL BOARD TB B ON THE REG TUBE RECT -TG PANEL IS WIRED TO TERMINAL 8 OF TERMINAL BOARD TB B ON THE REG TUBE RECT +TG PANEL. REFER TO THE REG TUBE RECT +TG PANEL WIRING DIAGRAM.
5. A TERMINAL ON RESISTOR C HAS BEEN FACTORY SELECTED SO THAT ITS RESISTANCE IS EQUAL TO THE TOTAL RESISTANCE STAMPED ON THERMISTOR T.
6. UNLESS OTHERWISE SPECIFIED, LEADS ARE 20 GA STRANDED WIRE; 16 GA WIRE IS STRANDED.
7.

SYMBOL	EXPLANATION
DI	WIRING RUN IN THE SHORTEST POSSIBLE MANNER.
PT	LEADS ARE PART OF THE APPARATUS.
BI	BOTTOM EDGE OF A TERMINAL BOARD.
B2	TERMINAL NEAREST TO PANEL.
B3	TERMINAL ON THE SIDE OF THE FUSE SOCKET.
KI	LEFT SIDE OF TERMINAL BOARD.

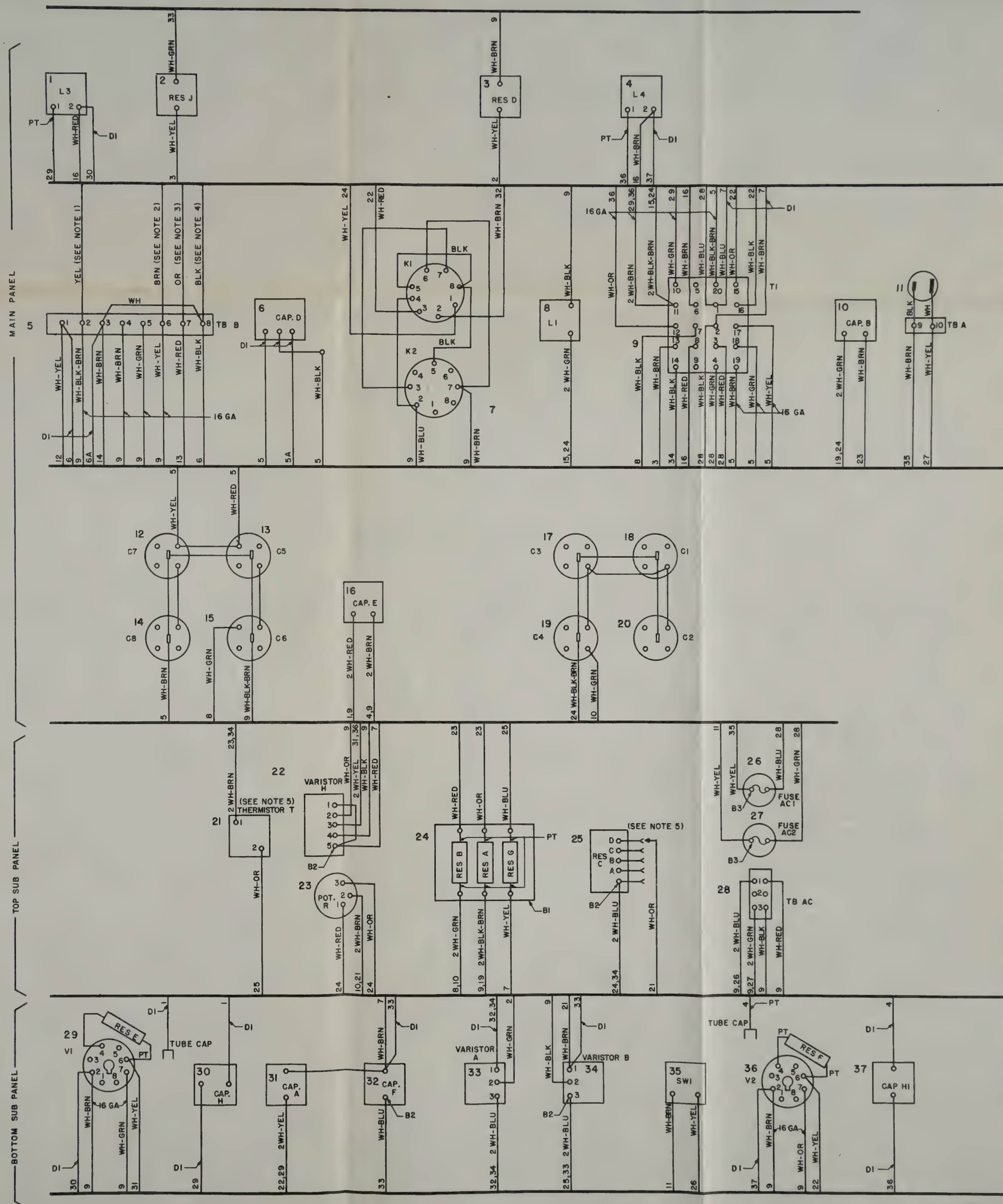
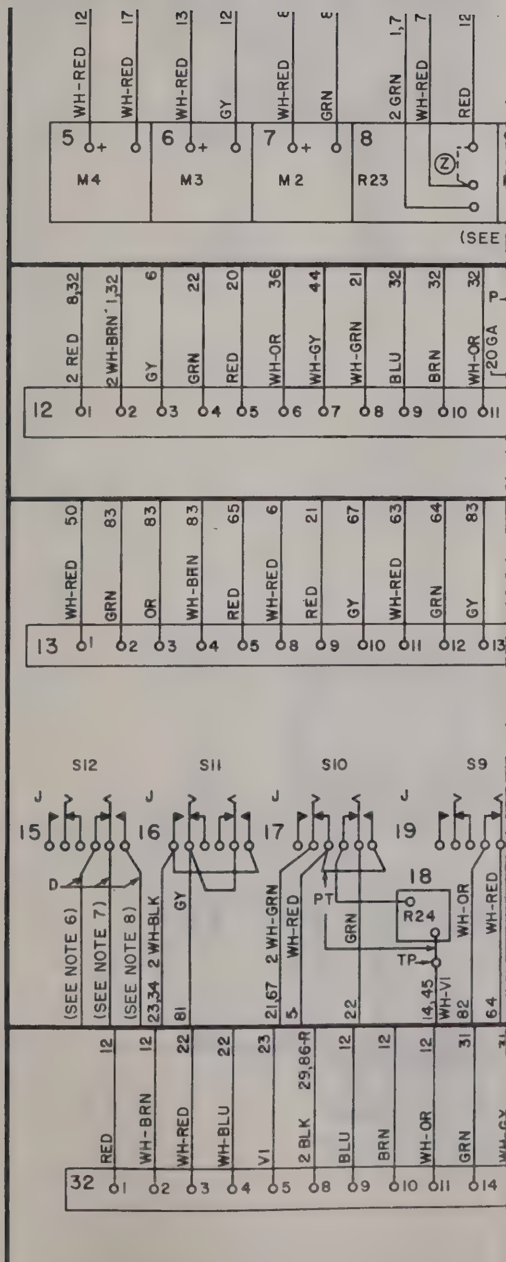
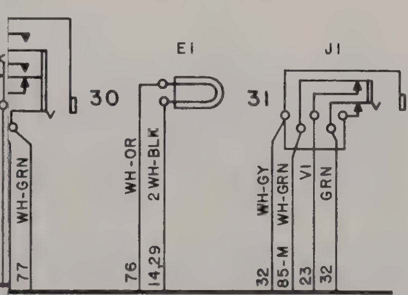


Figure 58. REG TUBE RECT—TG panel, wiring diagram.

TM 2224-105





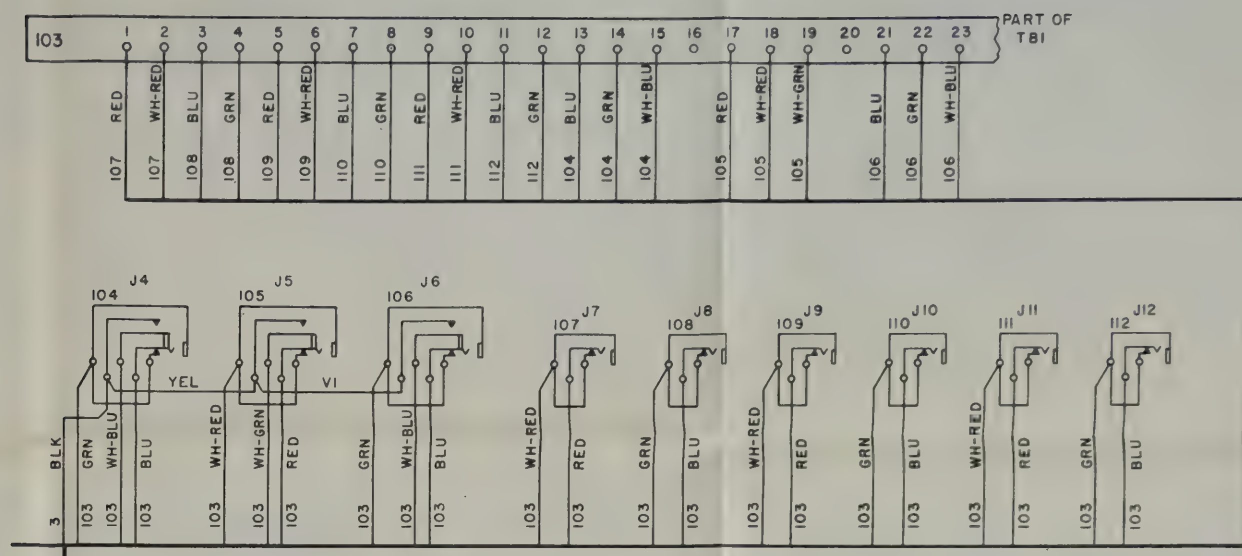
OF THE POWER SUPPLY CIRCUIT WIRING DIAGRAM.

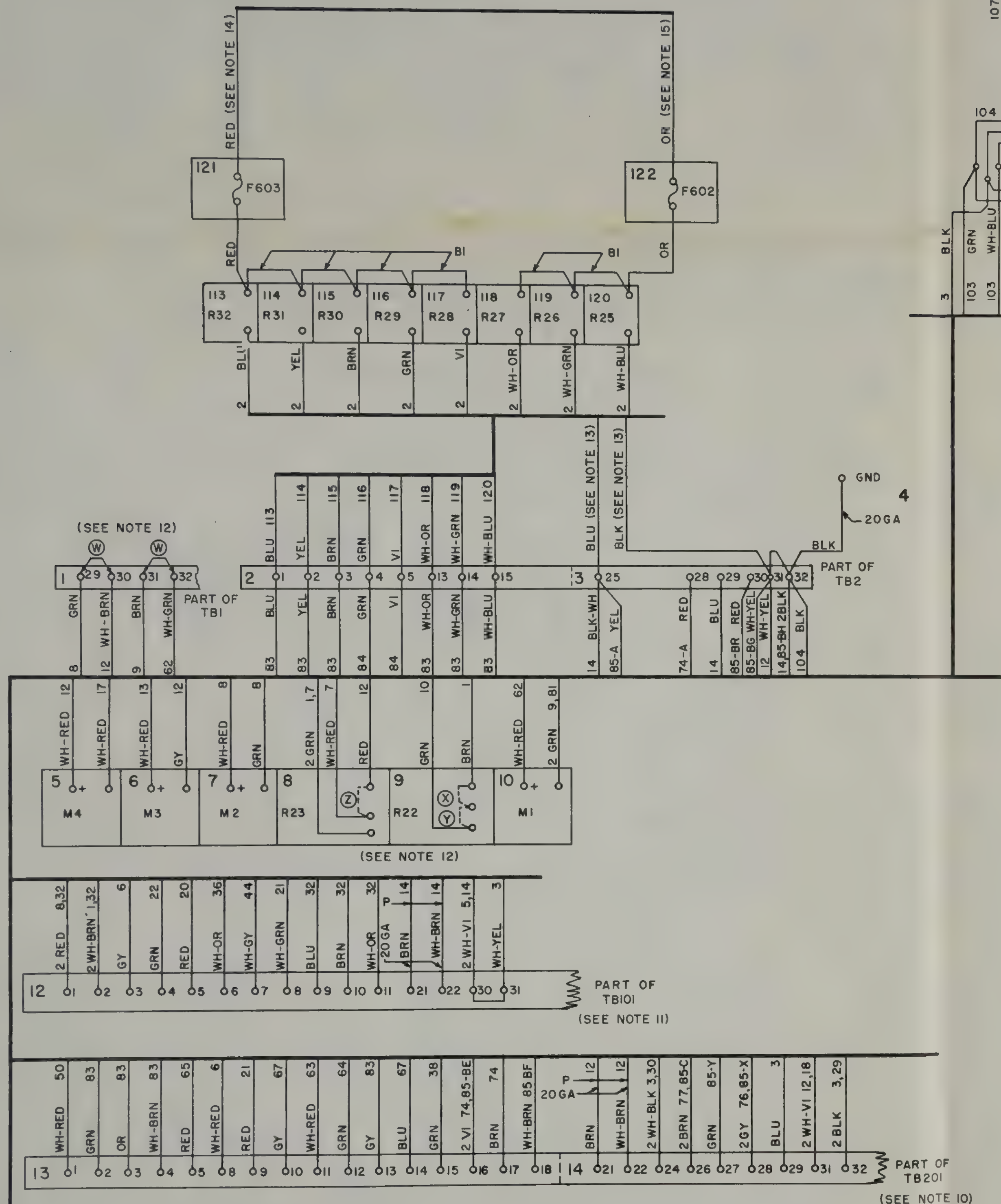
12. USE OF STRAPPING OPTIONS Ⓦ, Ⓧ, Ⓨ, AND Ⓩ IS DETERMINED BY THE NUMBER OF EXTENTION UNITS USED WITH THE TEST SET. SEE THE CHART BELOW.

NUMBER OF EXTENSION UNITS USED	STRAPPING OPTIONS REQUIRED
NONE	Ⓦ [a]
1 OR 2	NONE
3	Ⓧ
4 OR 5	Ⓧ AND Ⓨ
6, 7, OR 8	Ⓨ AND Ⓩ
9 OR MORE	Ⓧ Ⓨ, AND Ⓩ

[a] FACTORY INSTALLED ON NEW EQUIPMENT.

13. TERMINALS 25 AND 30 OF TERMINAL BOARD TB2 ARE ARE WIRED TO TERMINALS 5 AND 8 OF TERMINAL BOARD TB601. REFER TO STATION 3 ON THE 24 VOLT SUPPLY CIRCUIT WIRING DIAGRAM.
14. FUSE F603 IS WIRED TO TERMINAL 7 ON TERMINAL BOARD TB B OF THE $\boxed{\text{REG TUBE RECT + TG}}$ PANEL. REFER TO THE $\boxed{\text{REG TUBE RECT +TG}}$ PANEL WIRING DIAGRAM.
15. FUSE F602 IS WIRED TO TERMINAL 7 OF TERMINAL BOARD TB B OF THE $\boxed{\text{REG TUBE RECT -TG}}$ PANEL. REFER TO THE $\boxed{\text{REG TUBE RECT -TG}}$ PANEL WIRING DIAGRAM.
16. REFER TO STATION 78 OF THE EXTENSION RELAY CIRCUIT WIRING DIAGRAM.





NOTES:

1.

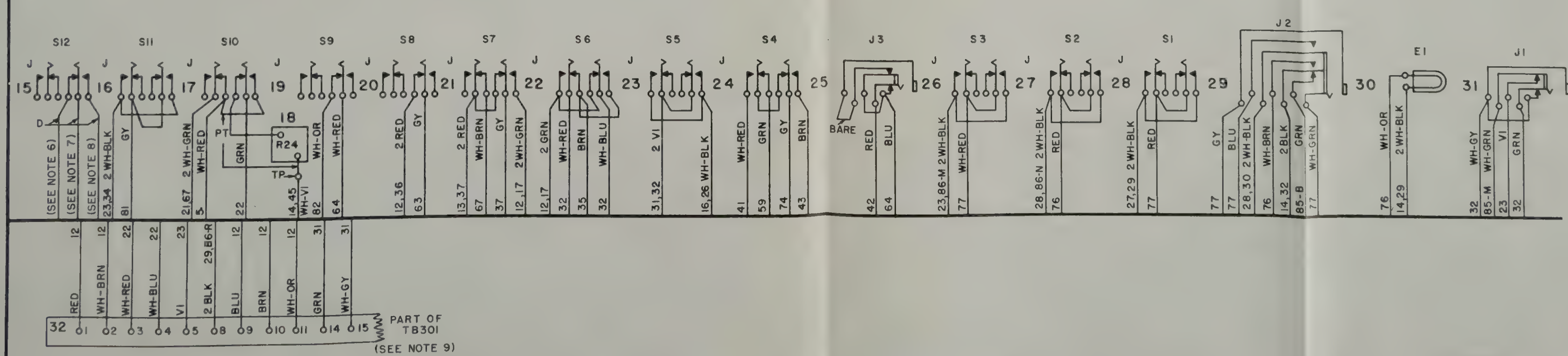
SYMBOL	EXPLANATION
BI	TERMINAL NEAREST PANEL
D	20 GA BLACK LEADS NOT INCLUDED IN A LOCAL CABLE, BUT RUN PARALLEL AND PERPENDICULAR TO THE PLANE AND EDGES OF A PANEL IN THE SHORTEST POSSIBLE MANNER.
DI	20 GA BLACK LEADS NOT INCLUDED IN A LOCAL CABLE, BUT RUN DIRECTLY BETWEEN TERMINALS IN THE SHORTEST POSSIBLE MANNER.
F	WIRE LEAVING CABLE FORM AND STITCHED SEPARATELY.
J	TOP OR LEFT SIDE OF SWITCH, LOOKING AT TERMINAL SIDE.
L	LIVE LEAD WHICH MUST BE INSULATED WHEN NOT CONNECTED TO APPARATUS.
LP	COILED WIRES AT UNEQUIPPED POSITIONS.
M	SPLICED AND INSULATED WIRES AT UNEQUIPPED POSITIONS.
P	PAIR OF WIRES.
PT	LEADS THAT ARE PART OF APPARATUS.
TP	TIE POINT

2. UNLESS OTHERWISE SPECIFIED, WIRES ARE 22 GA.
3. APPARATUS REPRESENTED BY STATION 101 IS NOT SUPPLIED, BUT IS REQUIRED FOR 20 MA, 96 VOLT OPERATION.
4. APPARATUS REPRESENTED BY STATIONS 89 THROUGH 97 ARE NOT SUPPLIED, BUT ARE REQUIRED FOR INVERSE NEUTRAL OPERATION.
5. TERMINAL 6T OF RELAY K12 AND TERMINAL 13T OF RELAY K6 ARE WIRED TO SWITCH S13. REFER TO THE AC SUPPLY CIRCUIT WIRING DIAGRAM.
6. THE FIXED BREAK CONTACT OF SWITCH S12 IS WIRED TO TERMINAL 5 OF TRANSFORMER T301. REFER TO STATION 37 ON THE RECTIFYING PEAK VOLTMETER CIRCUIT WIRING DIAGRAM.
7. THE MOVEABLE LOCKING CONTACT OF SWITCH S12 IS WIRED TO TERMINAL 4 OF XV 301. REFER TO STATION 7 ON THE RECTIFYING PEAK VOLTMETER CIRCUIT WIRING DIAGRAM.
8. THE FIXED MAKE CONTACT OF SWITCH S12 IS WIRED TO RESISTOR R228. REFER TO STATION 72 ON THE DISTRIBUTOR CIRCUIT WIRING DIAGRAM.
9. TERMINAL BOARD TB301 IS PART OF THE RECTIFYING PEAK VOLTMETER CIRCUIT. REFER TO STATION 38 OF THE RECTIFYING PEAK VOLTMETER CIRCUIT WIRING DIAGRAM.
10. TERMINAL BOARD TB201 IS PART OF THE DISTRIBUTOR CIRCUIT. REFER TO STATIONS 1 AND 2 OF THE DISTRIBUTOR CIRCUIT WIRING DIAGRAM.
11. TERMINAL BOARD TB101 IS PART OF THE POWER SUPPLY CIRCUIT. REFER TO STATIONS 22 AND 23 OF THE POWER SUPPLY CIRCUIT WIRING DIAGRAM.
12. USE OF STRAPPING OPTIONS W, X, Y, AND Z IS DETERMINED BY THE NUMBER OF EXTENTION UNITS USED WITH THE TEST SET. SEE THE CHART BELOW.

NUMBER OF EXTENSION UNITS USED	STRAPPING OPTIONS REQUIRED
NONE	W [a]
1 OR 2	NONE
3	X
4 OR 5	X AND Y
6, 7, OR 8	Y AND Z
9 OR MORE	X, Y, AND Z

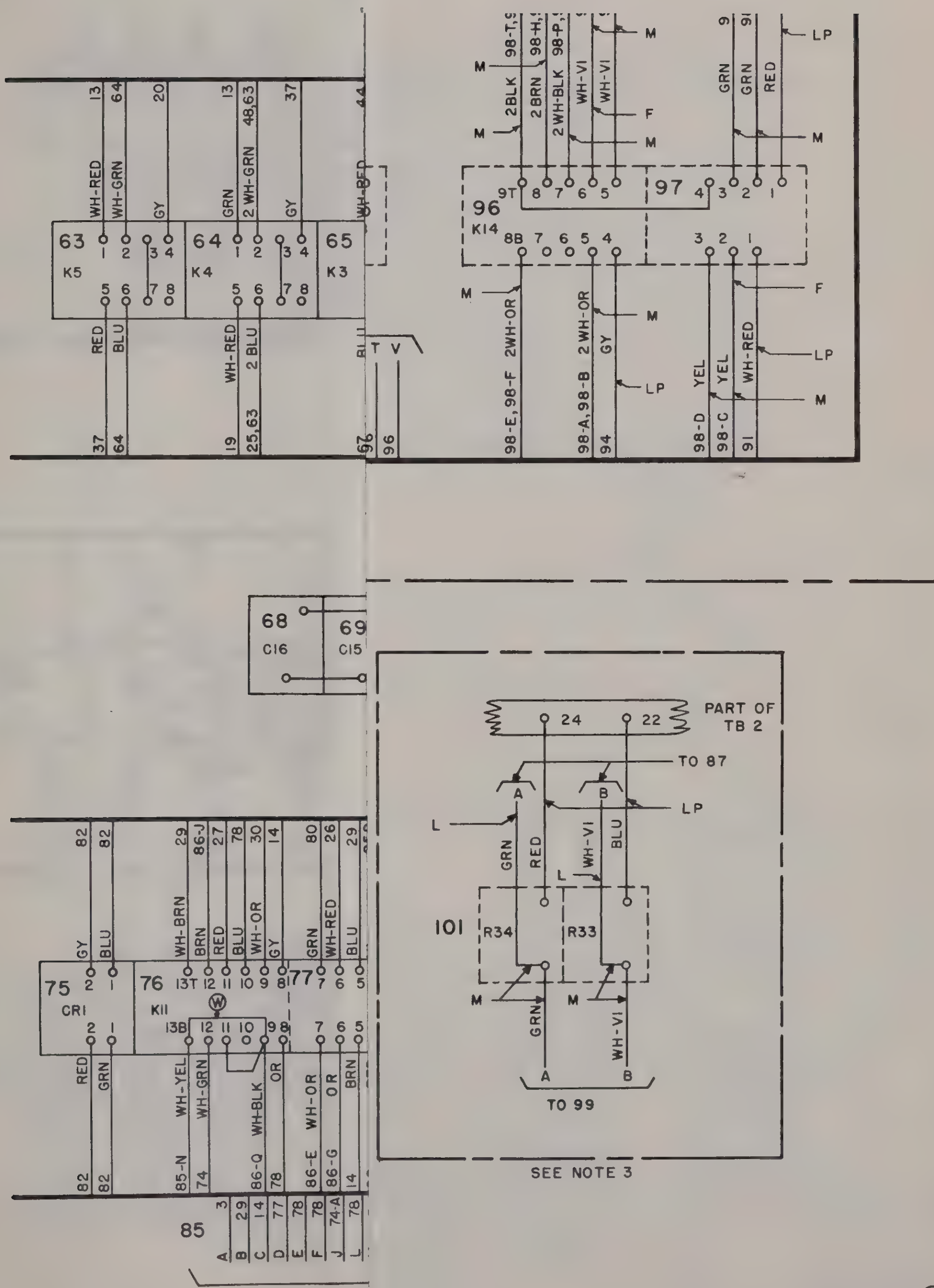
[a] FACTORY INSTALLED ON NEW EQUIPMENT.

13. TERMINALS 25 AND 30 OF TERMINAL BOARD TB2 ARE ARE WIRED TO TERMINALS 5 AND 8 OF TERMINAL BOARD TB601. REFER TO STATION 3 ON THE 24 VOLT SUPPLY CIRCUIT WIRING DIAGRAM.
14. FUSE F603 IS WIRED TO TERMINAL 7 ON TERMINAL BOARD TB B OF THE $\boxed{\text{REG TUBE RECT + TG}}$ PANEL. REFER TO THE $\boxed{\text{REG TUBE RECT +TG}}$ PANEL WIRING DIAGRAM.
15. FUSE F602 IS WIRED TO TERMINAL 7 OF TERMINAL BOARD TB B OF THE $\boxed{\text{REG TUBE RECT -TG}}$ PANEL. REFER TO THE $\boxed{\text{REG TUBE RECT -TG}}$ PANEL WIRING DIAGRAM.
16. REFER TO STATION 78 OF THE EXTENSION RELAY CIRCUIT WIRING DIAGRAM.



TM 2224-67 (1)

Figure 59. COMPT CKT panel, wiring diagram.


63
K5
64
K4
65
K3
96
K14
97
68
C16
69
C15
75
CR1
76
K11
77
85
101
R34
R33
PART OF
TB 2
TO 87
TO 99
SEE NOTE 3

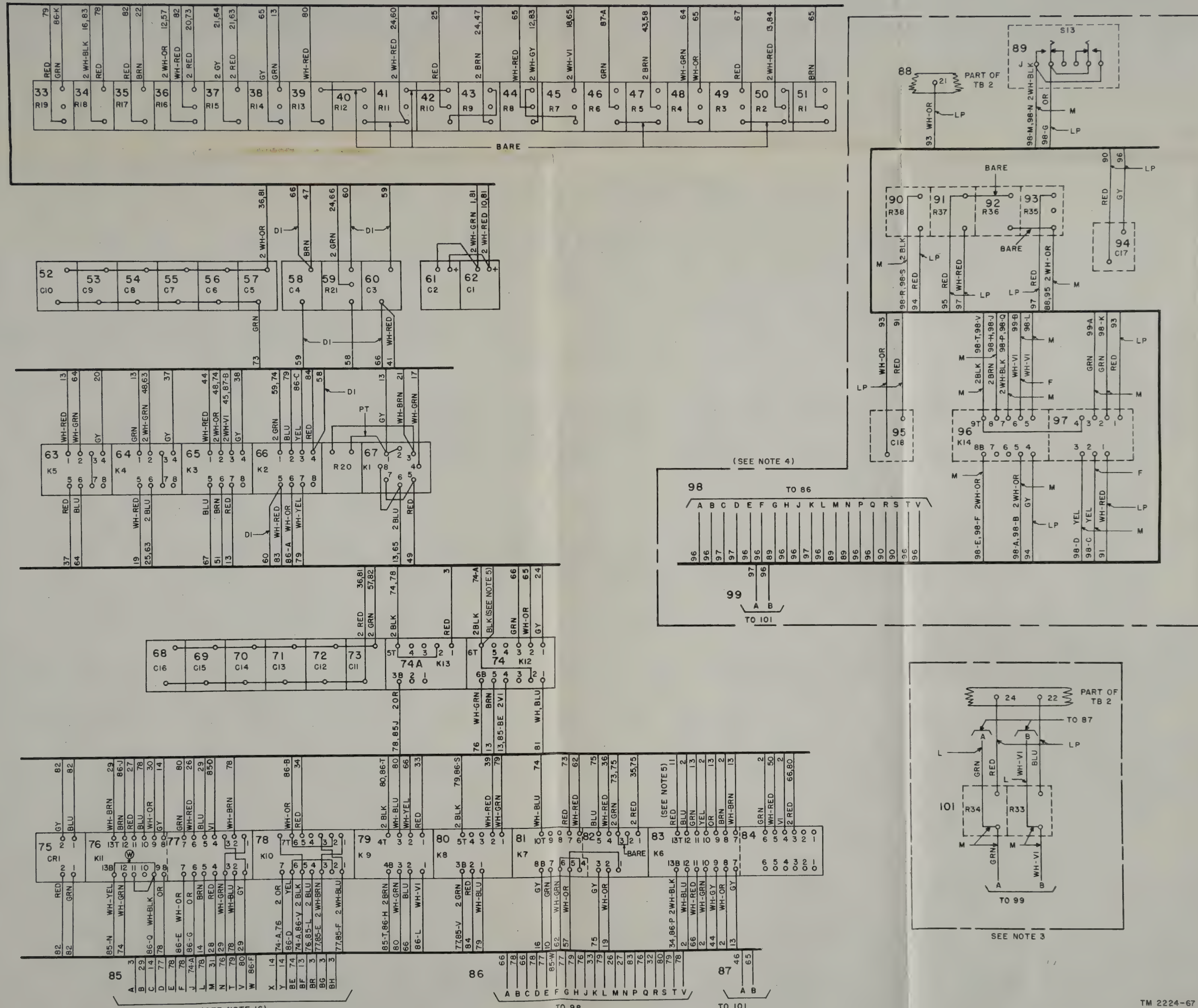
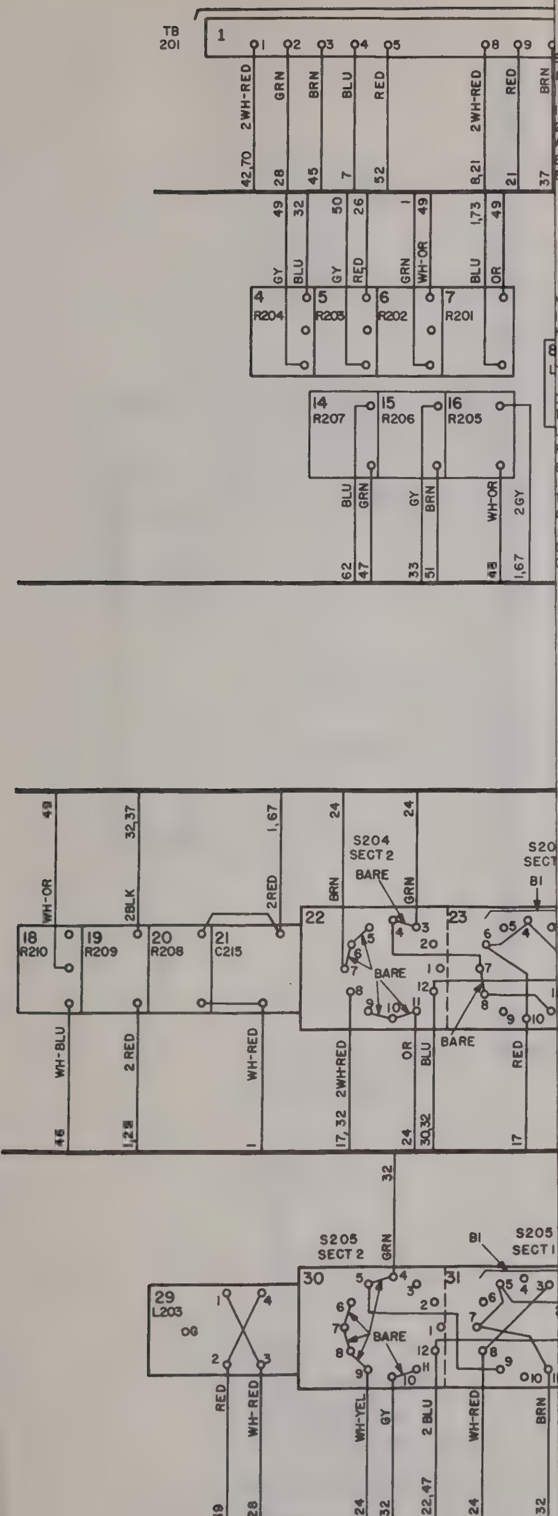


Figure 59. Continued.

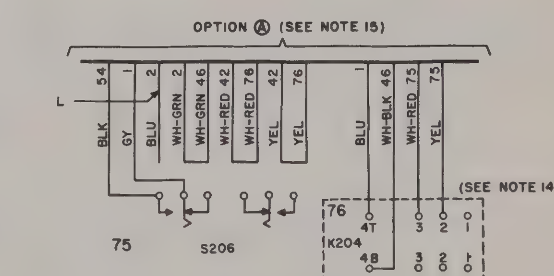


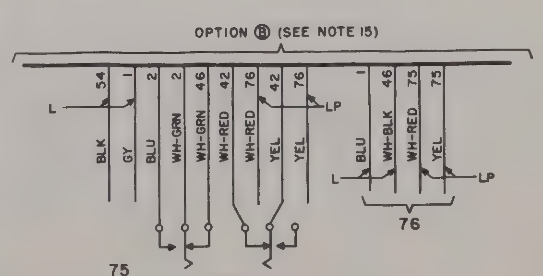
S:

NLESS OTHERWISE SPECIFIED, WIRES ARE 22 GA.
DENOTES PAIR.
DENOTES GANG NEAREST PANEL.
2 DENOTES EDGE OF MOUNTING NEAREST PANEL.
APACITORS ARE FACTORY STRAPPED SO THAT EACH COARSE SWITCH WILL BE AT THE ENTER OF ITS RANGE FOR NORMAL OPERATING SPEEDS. STRAPPING CHANGES ARE SELDOM EQUIRED. REFER TO THE CHART BELOW.

OPERATING SPEED (WPM)	APPLICABLE CAPACITOR
60	C219
75	C218
100	C216

NLESS OTHERWISE SPECIFIED, DI WIRING IS USED FOR STRAPS.
DENOTES BLACK, 20 GA, WIRE THAT RUNS DIRECTLY BETWEEN TERMINALS IN THE HORTEST POSSIBLE MANNER.
DENOTES BLACK, 20 GA, WIRE THAT RUNS PARALLEL AND PERPENDICULAR TO THE LANE AND EDGES OF THE PANEL IN THE SHORTEST POSSIBLE MANNER.
DENOTES LIVE LEADS WHICH MUST BE INSULATED WHEN NOT CONNECTED TO APPARATUS.
OR CONNECTION TO RESISTOR R228, REFER TO THE INTERCONNECTION DIAGRAM AND TO TATION 15 ON THE COMPARISON CIRCUIT WIRING DIAGRAM.
LUG P201 CONTAINS TWO 1/2 AMP FUSES.
P DENOTES COILED WIRES AT UNEQUIPPED POSITIONS.
ERMINALS ON TERMINAL BOARD TB201 ARE WIRED TO ELEMENTS OF THE COMPARISON IRCUIT, THE POWER SUPPLY CIRCUIT, AND THE EXTENSION RELAY CIRCUITS. REFER TO TATIONS 13 AND 14 OF THE COMPARISON CIRCUIT WIRING DIAGRAM.
ASHED LINES DENOTE OPTIONAL EQUIPMENT, NOT NORMALLY FURNISHED.
IRING OPTION Ⓑ IS PROVIDED AT THE FACTORY AND DOES NOT PERMIT REMOTE ONTROL FOR 5-6 CODE OPERATION. USE WIRING OPTION Ⓐ TO PROVIDE REMOTE ONTROL FOR 5-6 CODE OPERATION.





TM 2224-68

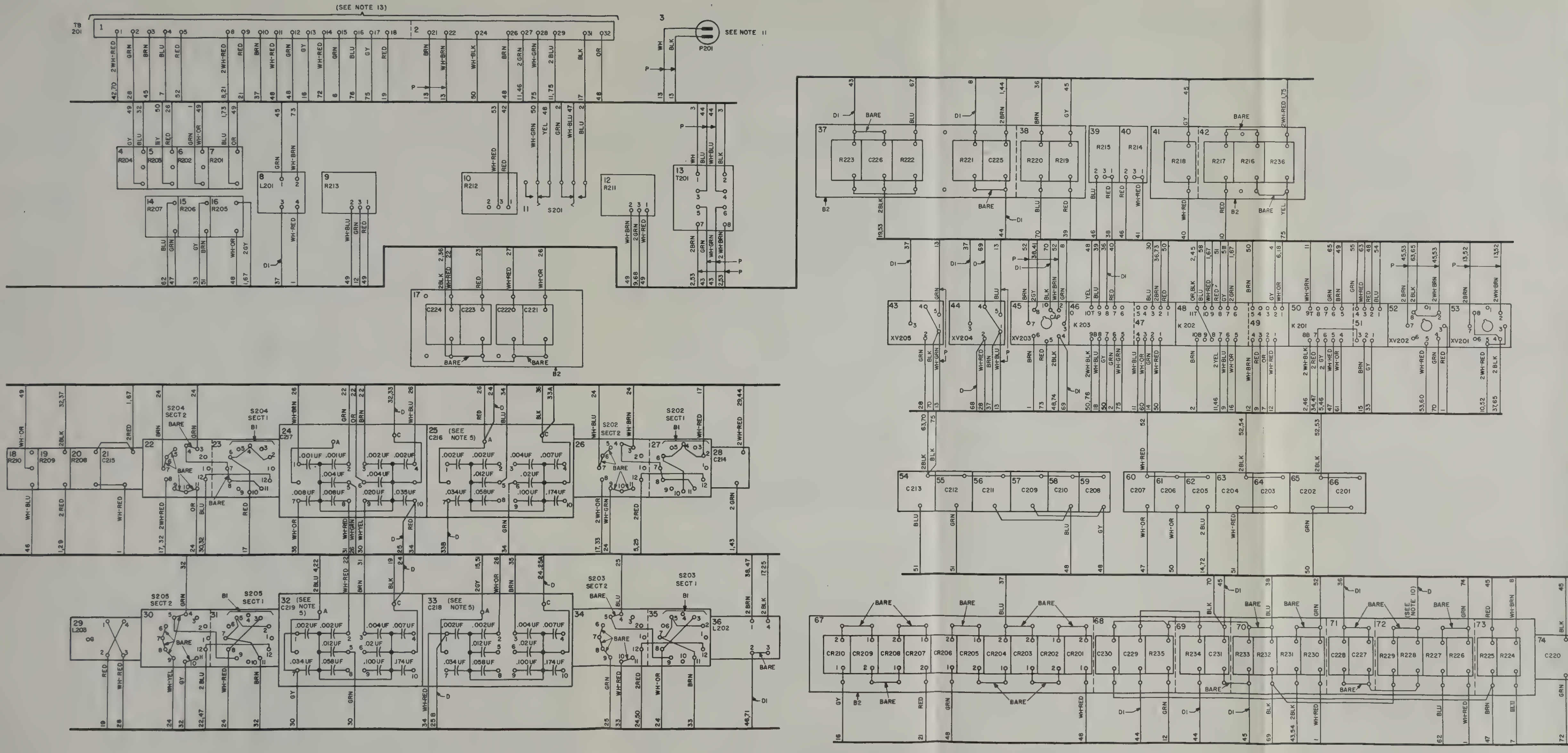


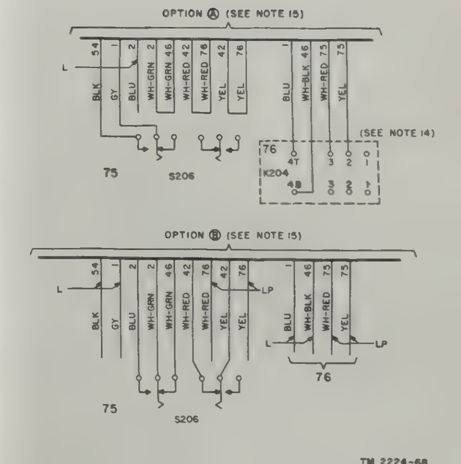
Figure 61. DISTRIBUTOR panel, wiring diagram.

NOTES

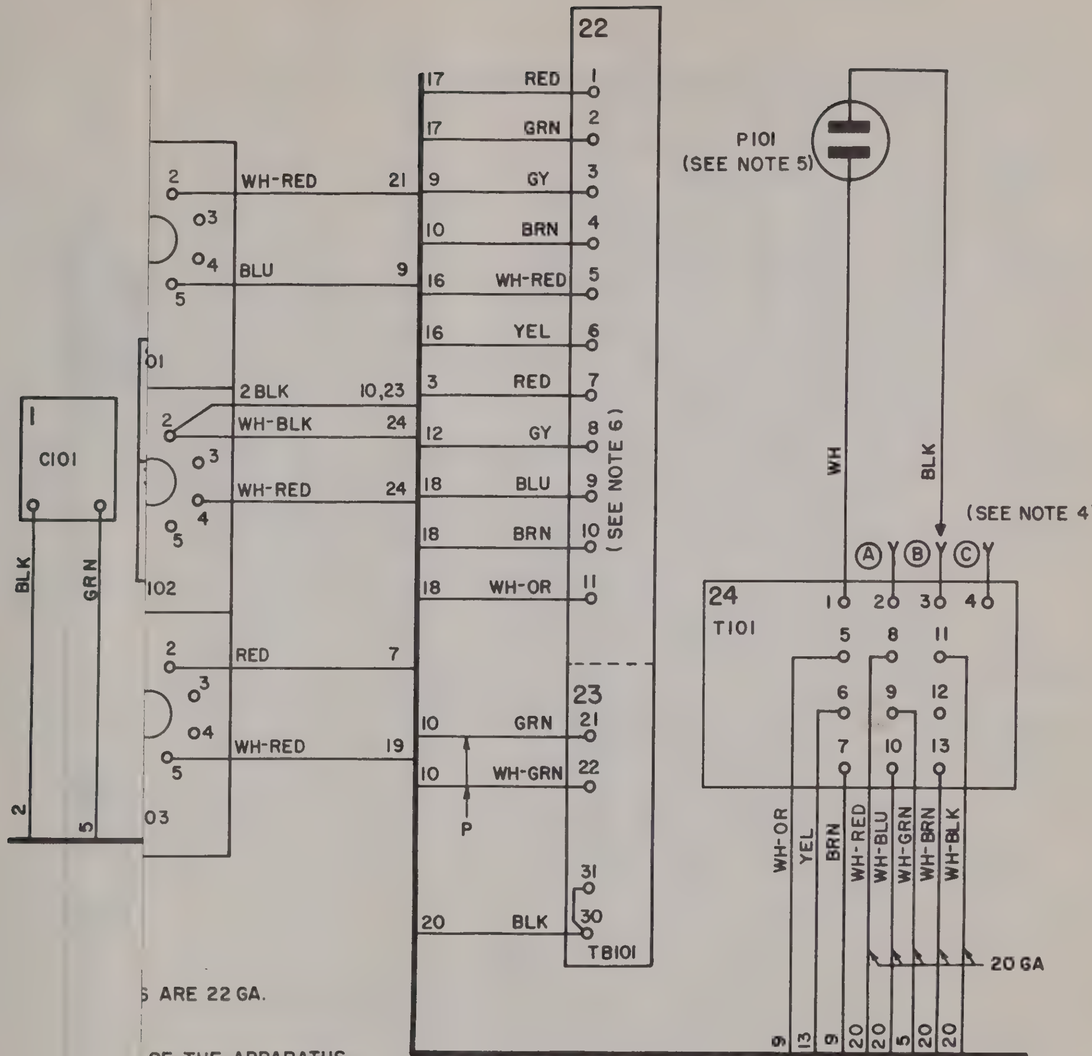
1. UNLESS OTHERWISE SPECIFIED, WIRES ARE 22 GA.
2. P DENOTES PAIR
3. B DENOTES GANG NEAREST PANEL
4. B2 DENOTES EDGE OF MOUNTING NEAREST PANEL
5. CAPACITORS ARE FACTORY STRAPPED SO THAT EACH COARSE SWITCH WILL BE AT THE CENTER OF ITS RANGE FOR NORMAL OPERATING SPEEDS. STRAPPING CHANGES ARE SELDOM REQUIRED REFER TO THE CHART BELOW

OPERATING SPEED (WPM)	APPLICABLE CAPACITOR
60	C219
75	C218
100	C216

6. UNLESS OTHERWISE SPECIFIED, DI WIRING IS USED FOR STRAPS.
7. DI DENOTES BLACK, 20 GA, WIRE THAT RUNS DIRECTLY BETWEEN TERMINALS IN THE SHORTEST POSSIBLE MANNER
8. D DENOTES BLACK, 20 GA, WIRE THAT RUNS PARALLEL AND PERPENDICULAR TO THE PLANE AND EDGES OF THE PANEL IN THE SHORTEST POSSIBLE MANNER.
9. L DENOTES LIVE LEADS WHICH MUST BE INSULATED WHEN NOT CONNECTED TO APPARATUS.
10. FOR CONNECTION TO RESISTOR R228, REFER TO THE INTERCONNECTION DIAGRAM AND TO STATION 15 ON THE COMPARISON CIRCUIT WIRING DIAGRAM.
11. PLUG P201 CONTAINS TWO 1/2 AMP FUSES.
12. LP DENOTES COILED WIRES AT UNEQUIPPED POSITIONS.
13. TERMINALS ON TERMINAL BOARD TB201 ARE WIRED TO ELEMENTS OF THE COMPARISON CIRCUIT, THE POWER SUPPLY CIRCUIT, AND THE EXTENSION RELAY CIRCUITS. REFER TO STATIONS 13 AND 14 OF THE COMPARISON CIRCUIT WIRING DIAGRAM
14. DASHED LINES DENOTE OPTIONAL EQUIPMENT, NOT NORMALLY FURNISHED.
15. WIRING OPTION Ⓑ IS PROVIDED AT THE FACTORY AND DOES NOT PERMIT REMOTE CONTROL FOR 5-6 CODE OPERATION. USE WIRING OPTION Ⓐ TO PROVIDE REMOTE CONTROL FOR 5-6 CODE OPERATION.



TM 2224-68



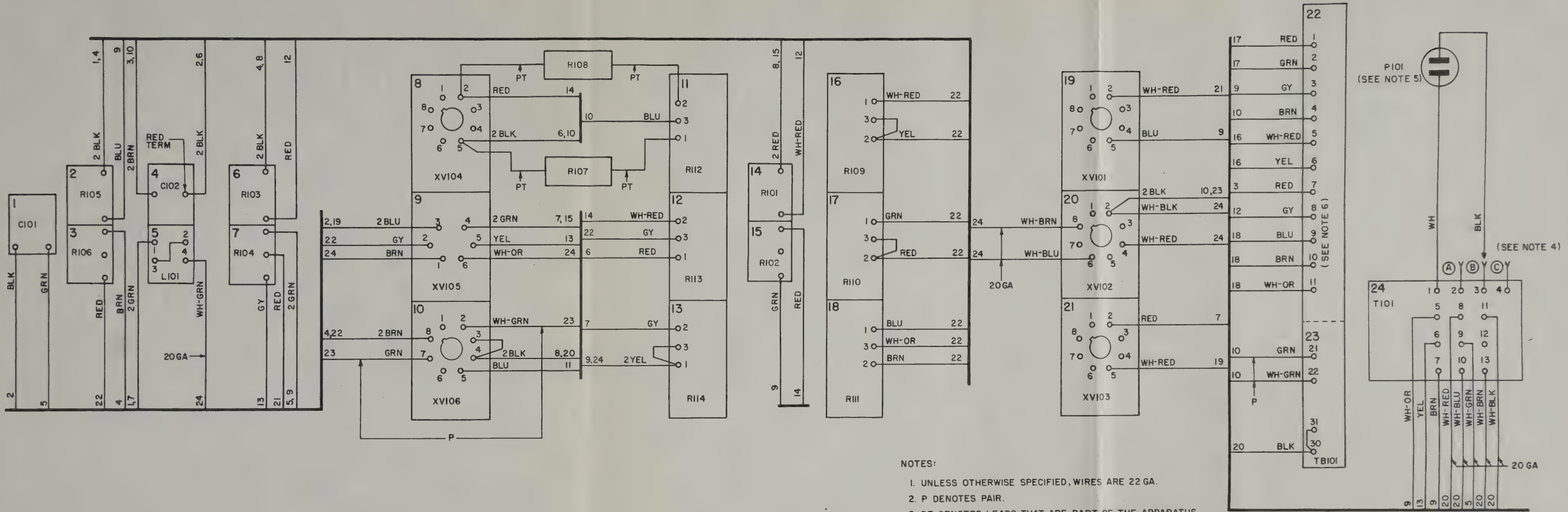
; ARE 22 GA.

OF THE APPARATUS.
ROPER WIRING

OPTION
Ⓐ
Ⓑ
Ⓒ

FUSES.
101 ARE WIRED TO
THE RECTIFYING
ENSION UNIT CIRCUITS,
ER TO STATION 12 ON
AGRAM.

TM2224-70



NOTES:

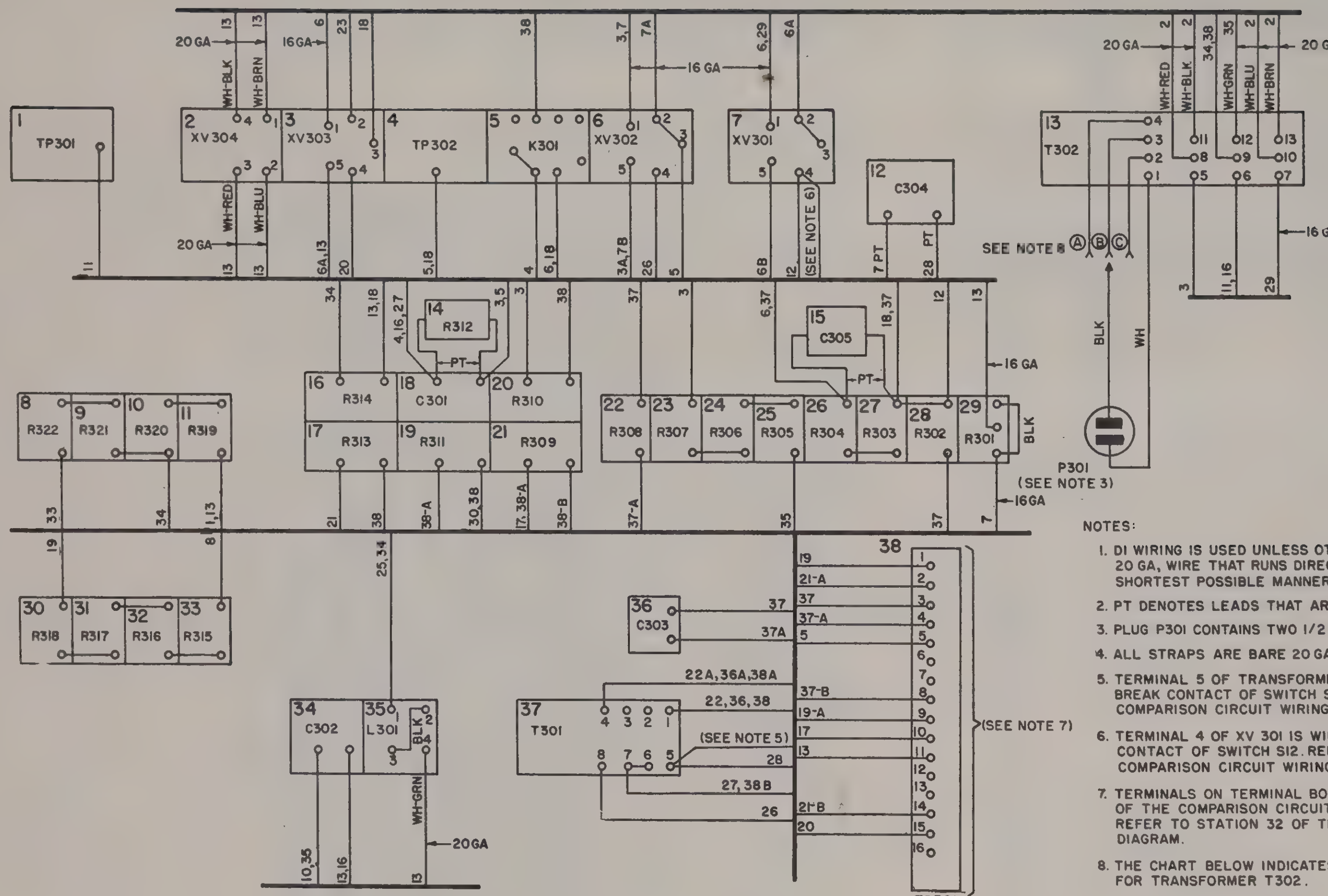
1. UNLESS OTHERWISE SPECIFIED, WIRES ARE 22 GA.
2. P DENOTES PAIR.
3. PT DENOTES LEADS THAT ARE PART OF THE APPARATUS.
4. THE CHART BELOW INDICATES THE PROPER WIRING OPTION FOR TRANSFORMER T101.

AC LINE VOLTAGE	OPTION
LESS THAN 111	Ⓐ
BETWEEN 111 AND 119	Ⓑ
MORE THAN 119	Ⓒ

5. PLUG P101 CONTAINS TWO 1/2 AMP FUSES.
6. TERMINALS ON TERMINAL BOARD TB101 ARE WIRED TO ELEMENTS OF COMPARISON CIRCUIT, THE RECTIFYING PEAK VOLTMETER CIRCUIT, THE EXTENSION UNIT CIRCUITS, AND THE DISTRIBUTOR CIRCUIT. REFER TO STATION 12 ON THE COMPARISON CIRCUIT WIRING DIAGRAM.

TM2224-70

Figure 62. PWR SUP panel, wiring diagram.



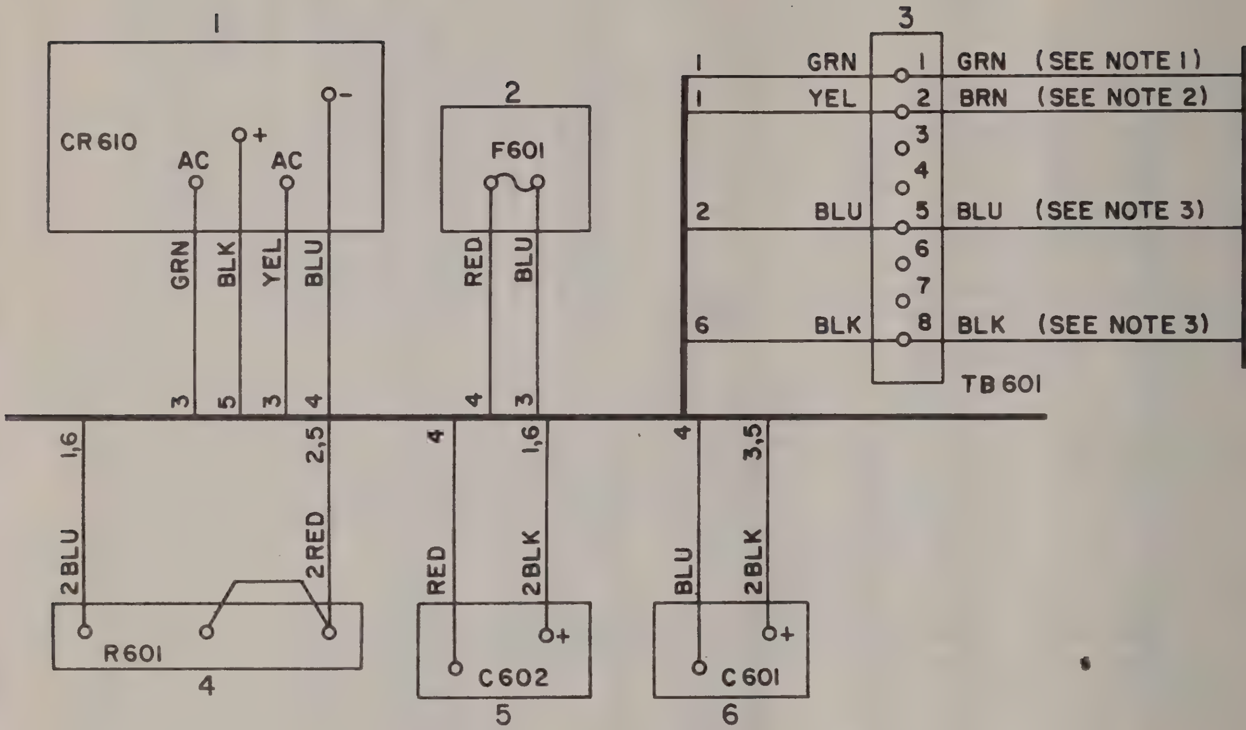
NOTES:

1. DI WIRING IS USED UNLESS OTHERWISE SPECIFIED. DI DENOTES BLACK, 20 GA, WIRE THAT RUNS DIRECTLY BETWEEN TERMINALS IN THE SHORTEST POSSIBLE MANNER.
2. PT DENOTES LEADS THAT ARE PART OF THE APPARATUS.
3. PLUG P301 CONTAINS TWO 1/2 AMP FUSES.
4. ALL STRAPS ARE BARE 20 GA WIRE UNLESS OTHERWISE SPECIFIED.
5. TERMINAL 5 OF TRANSFORMER T301 IS WIRED TO THE FIXED BREAK CONTACT OF SWITCH S12. REFER TO STATION 15 OF THE COMPARISON CIRCUIT WIRING DIAGRAM.
6. TERMINAL 4 OF XV 301 IS WIRED TO THE MOVABLE LOCKING CONTACT OF SWITCH S12. REFER TO STATION 15 OF THE COMPARISON CIRCUIT WIRING DIAGRAM.
7. TERMINALS ON TERMINAL BOARD TB301 ARE WIRED TO ELEMENTS OF THE COMPARISON CIRCUIT AND THE POWER SUPPLY CIRCUIT. REFER TO STATION 32 OF THE COMPARISON CIRCUIT WIRING DIAGRAM.
8. THE CHART BELOW INDICATES THE PROPER WIRING OPTION FOR TRANSFORMER T302.

AC LINE VOLTAGE	OPTION
MORE THAN 119.	Ⓐ
BETWEEN 111 AND 119	Ⓑ
LESS THAN 111	Ⓒ

TM2224-69

Figure 60. RECT PEAK VM panel, wiring diagram.



NOTES:

1. TERMINAL 1 OF TERMINAL BOARD TB601 IS WIRED TO TERMINAL 2 OF TERMINAL BOARD TB B. REFER TO STATION 5 OF THE REG TUBE RECT + TG PANEL WIRING DIAGRAM.

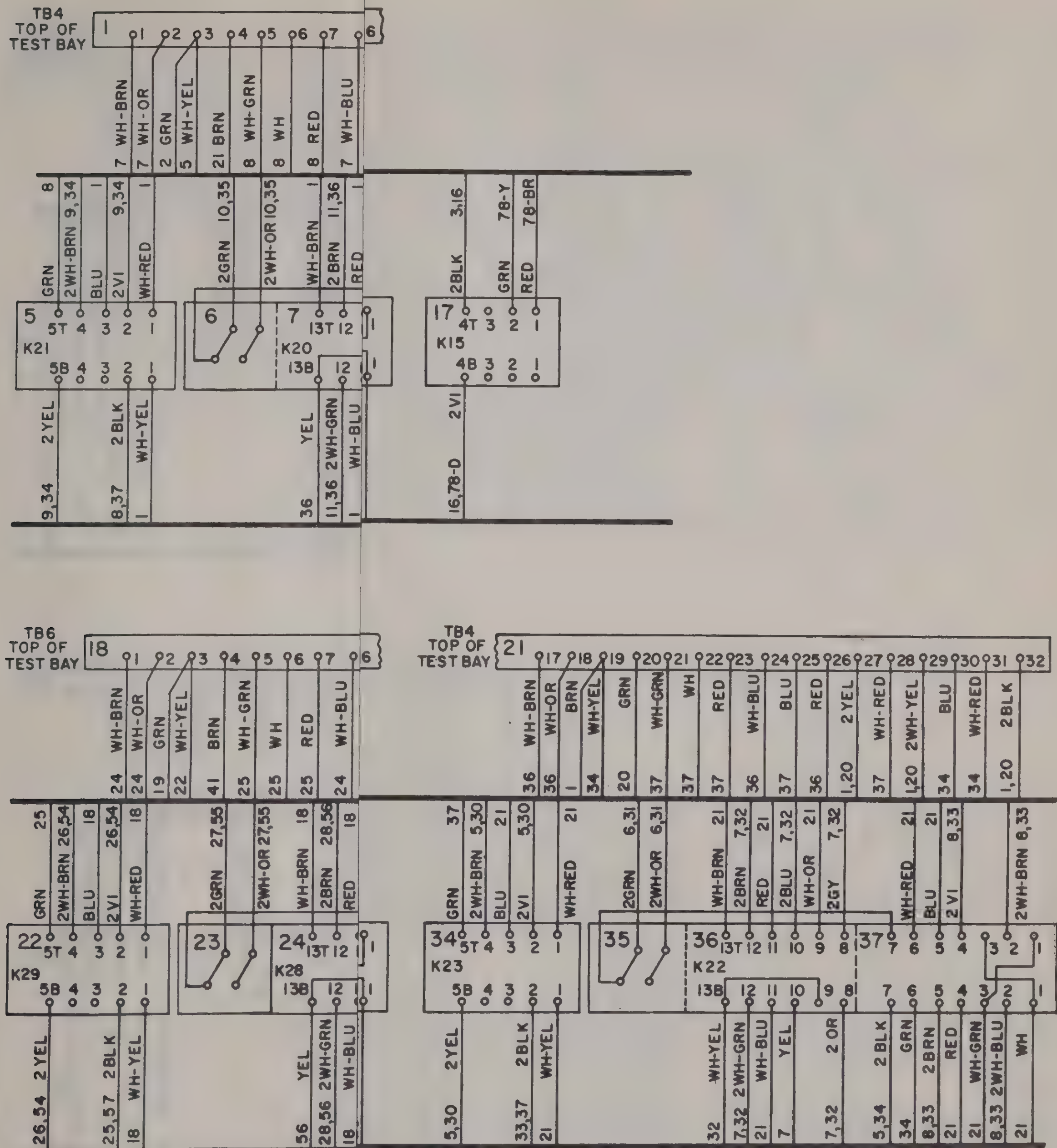
2. TERMINAL 2 OF TERMINAL BOARD TB601 IS WIRED TO TERMINAL 6 OF TERMINAL BOARD TB B. REFER TO STATION 5 OF THE REG TUBE RECT − TG PANEL WIRING DIAGRAM.

3. TERMINALS 5 AND 8 OF TERMINAL BOARD TB601 ARE WIRED TO TERMINALS 25 AND 30 OF TERMINAL BOARD TB2. REFER TO STATION 3 OF THE COMPARISON CIRCUIT WIRING DIAGRAM.

4. ALL WIRES ARE STRANDED, 20 GA.

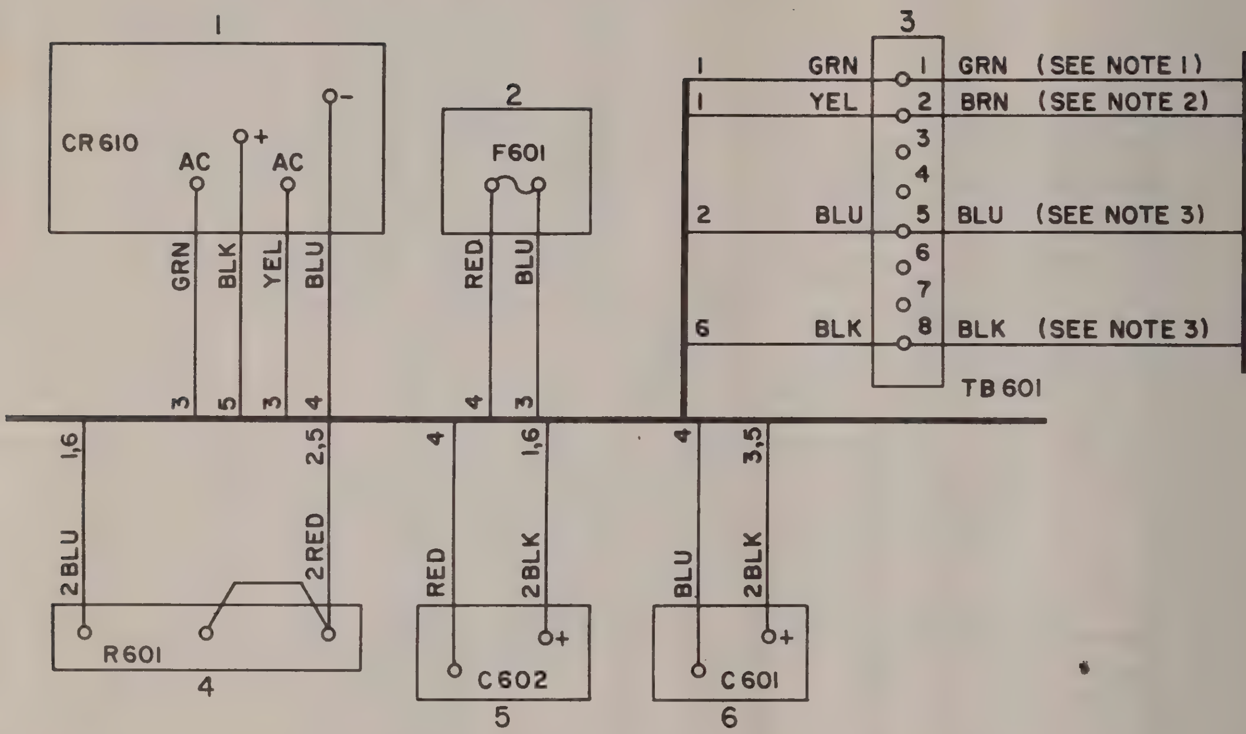
TM2224-74

Figure 63. 24 VOLT SUP panel, wiring diagram.



TM2224-71(1)

368962 O—56 (Face p. 126) No. 1



NOTES:

1. TERMINAL 1 OF TERMINAL BOARD TB601 IS WIRED TO TERMINAL 2 OF TERMINAL BOARD TB B. REFER TO STATION 5 OF THE REG TUBE RECT +TG PANEL WIRING DIAGRAM.

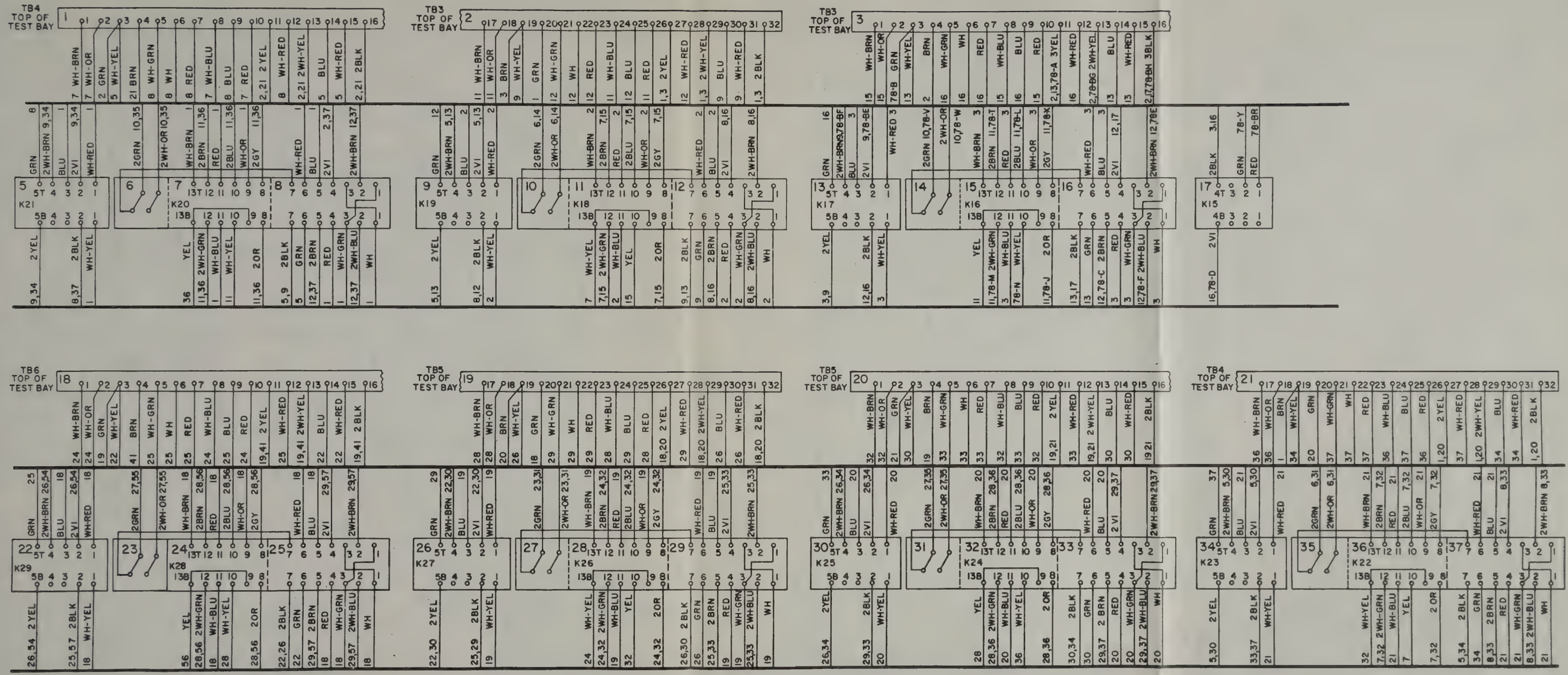
2. TERMINAL 2 OF TERMINAL BOARD TB601 IS WIRED TO TERMINAL 6 OF TERMINAL BOARD TB B. REFER TO STATION 5 OF THE REG TUBE RECT −TG PANEL WIRING DIAGRAM.

3. TERMINALS 5 AND 8 OF TERMINAL BOARD TB601 ARE WIRED TO TERMINALS 25 AND 30 OF TERMINAL BOARD TB 2. REFER TO STATION 3 OF THE COMPARISON CIRCUIT WIRING DIAGRAM.

4. ALL WIRES ARE STRANDED, 20 GA.

TM2224-74

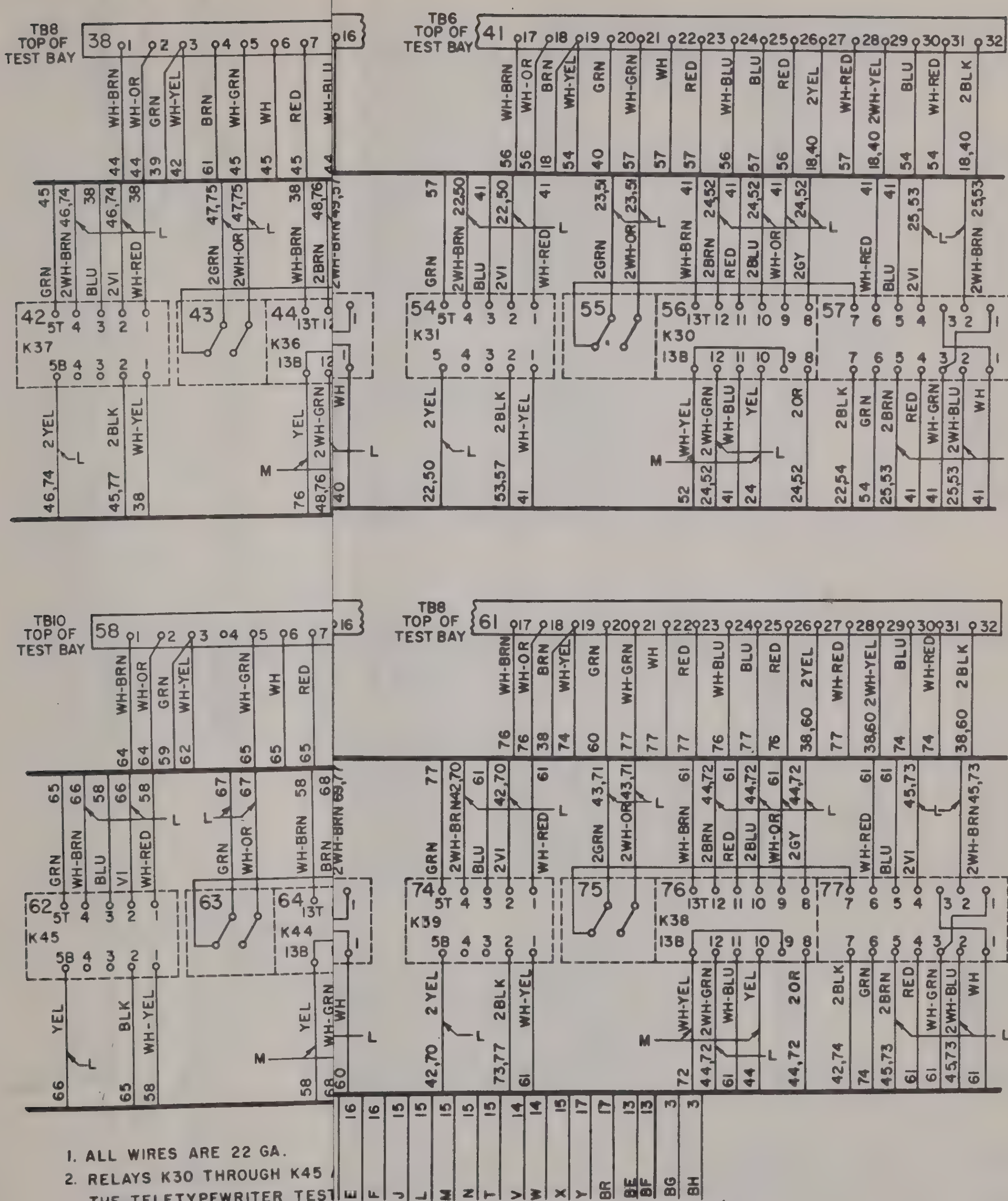
Figure 63. 24 VOLT SUP panel, wiring diagram.



① *Extension relay circuits 1 through 7.*

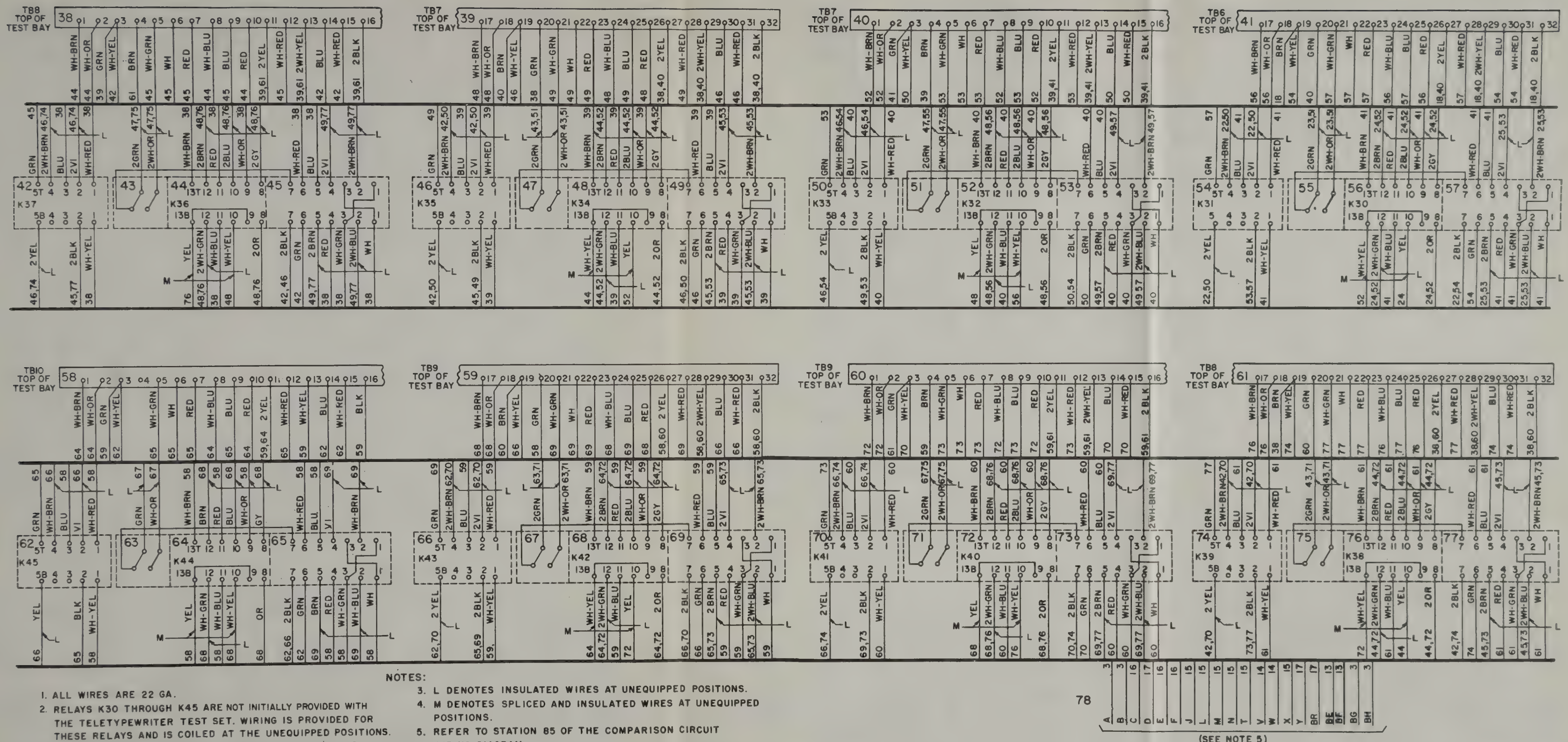
Figure 64. EXT CKT panels, wiring diagram.

TM2224-71①



1. ALL WIRES ARE 22 GA.
2. RELAYS K30 THROUGH K45 A
THE TELETYPEWRITER TEST
THESE RELAYS AND IS COILE
WHEN ADDITIONAL RELAYS A
EXTENSION UNITS 8 THROUG
CONNECTED AS INDICATED C

TM 2224-71 ②



NOTES:

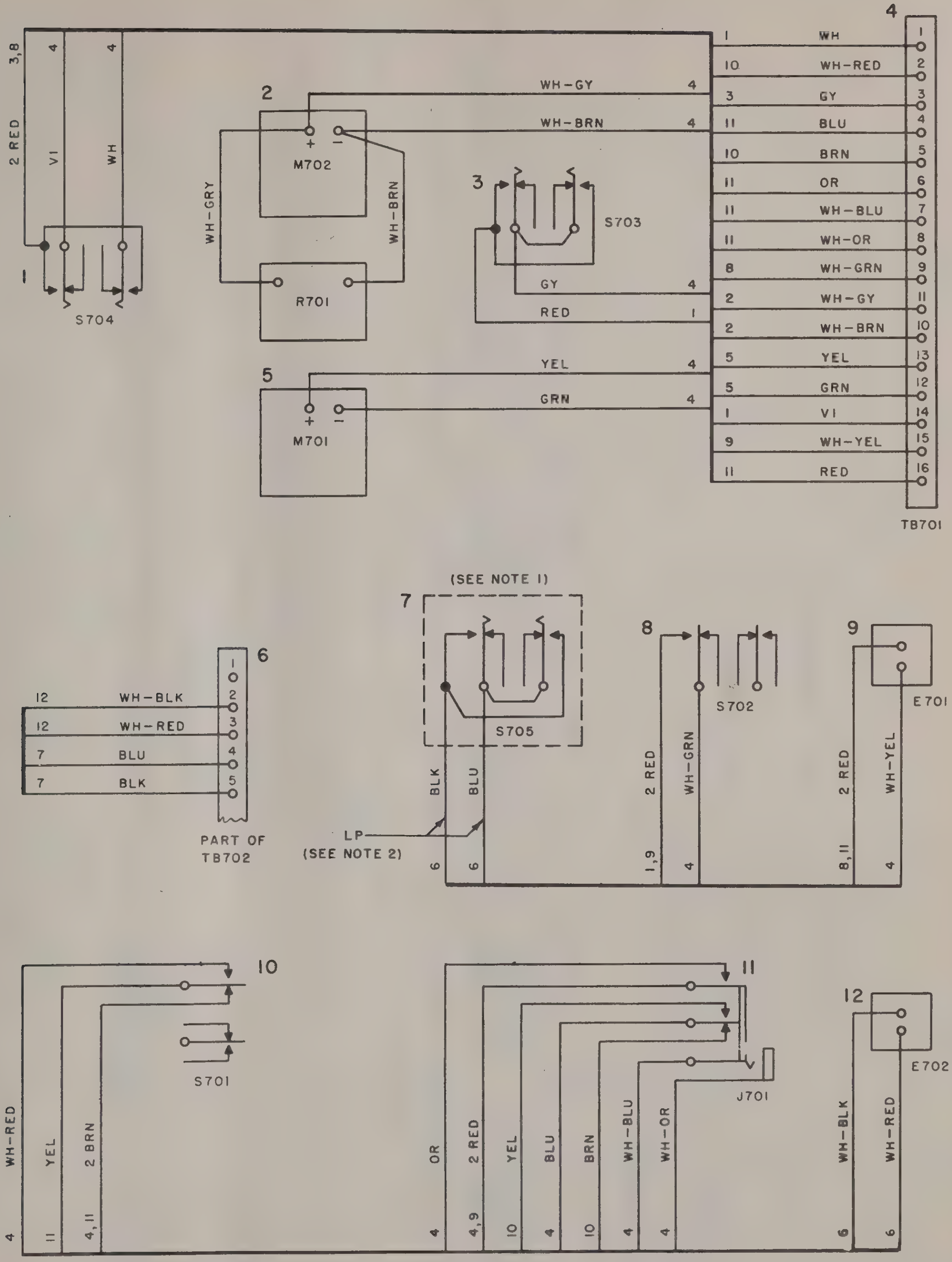
1. ALL WIRES ARE 22 GA.
2. RELAYS K30 THROUGH K45 ARE NOT INITIALLY PROVIDED WITH THE TELETYPEWRITER TEST SET. WIRING IS PROVIDED FOR THESE RELAYS AND IS COILED AT THE UNEQUIPPED POSITIONS. WHEN ADDITIONAL RELAYS ARE INSTALLED FOR USE WITH EXTENSION UNITS 8 THROUGH 15, THE RELAYS MUST BE CONNECTED AS INDICATED ON THIS WIRING DIAGRAM.
3. L DENOTES INSULATED WIRES AT UNEQUIPPED POSITIONS.
4. M DENOTES SPLICED AND INSULATED WIRES AT UNEQUIPPED POSITIONS.
5. REFER TO STATION 85 OF THE COMPARISON CIRCUIT WIRING DIAGRAM.

TM 2224-71 ②

② *Extension relay circuits 8 through 15.*

Figure 64. Continued.

368962 O—56 (Face p. 126) No. 2

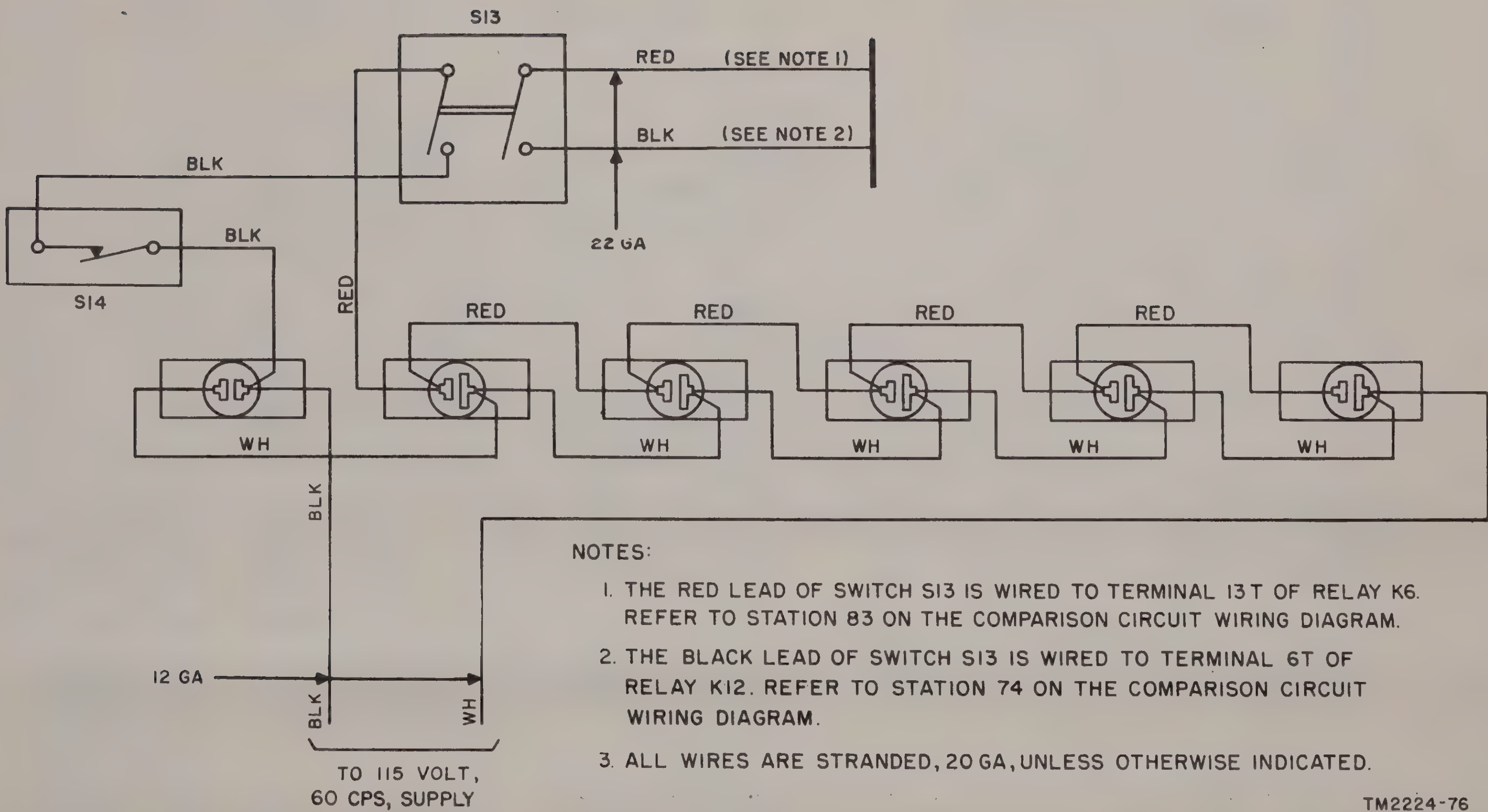


NOTES:

1. DASHED LINE DENOTES EQUIPMENT NOT NORMALLY FURNISHED.
2. LP DENOTES COILED WIRES AT AN UNEQUIPPED POSITION.

TM2224-72

Figure 65. Extension unit, wiring diagram.

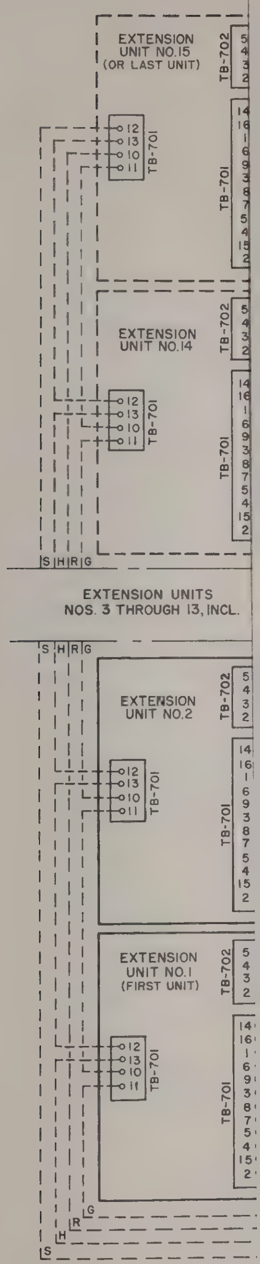


NOTES:

1. THE RED LEAD OF SWITCH S13 IS WIRED TO TERMINAL 13T OF RELAY K6. REFER TO STATION 83 ON THE COMPARISON CIRCUIT WIRING DIAGRAM.
2. THE BLACK LEAD OF SWITCH S13 IS WIRED TO TERMINAL 6T OF RELAY K12. REFER TO STATION 74 ON THE COMPARISON CIRCUIT WIRING DIAGRAM.
3. ALL WIRES ARE STRANDED, 20 GA, UNLESS OTHERWISE INDICATED.

TM2224-76

Figure 66. Ac supply circuit, wiring diagram.



NOTES:

1. DASHED LINI NORMALLY F PROVIDED B
2. (+),(−) INDI(LEADS UNDE
3. HEAVY LINES CONNECTION CIRCUIT, THI
4. HEAVY TRA(MAIN BAY G TO OTHER (

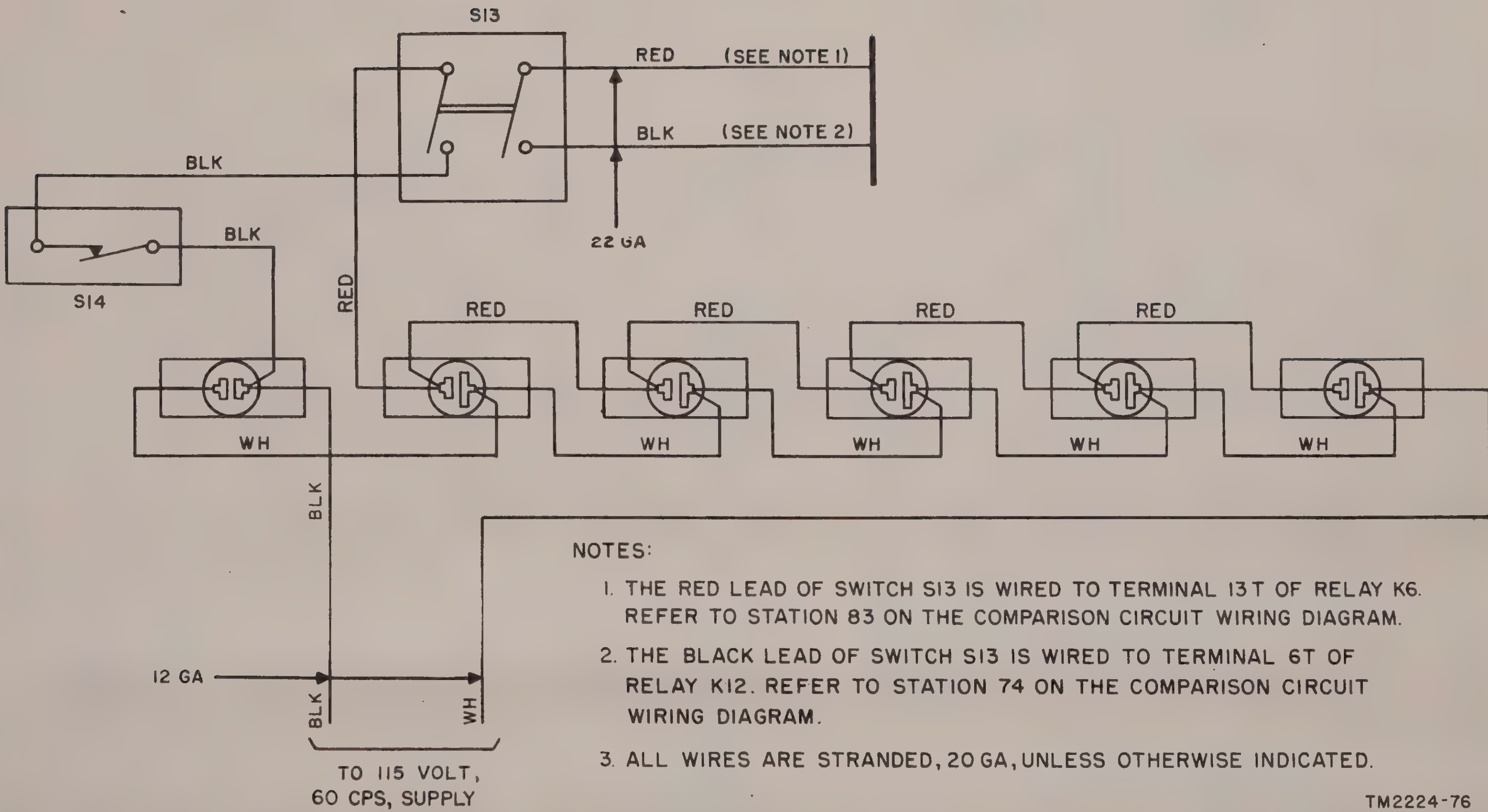
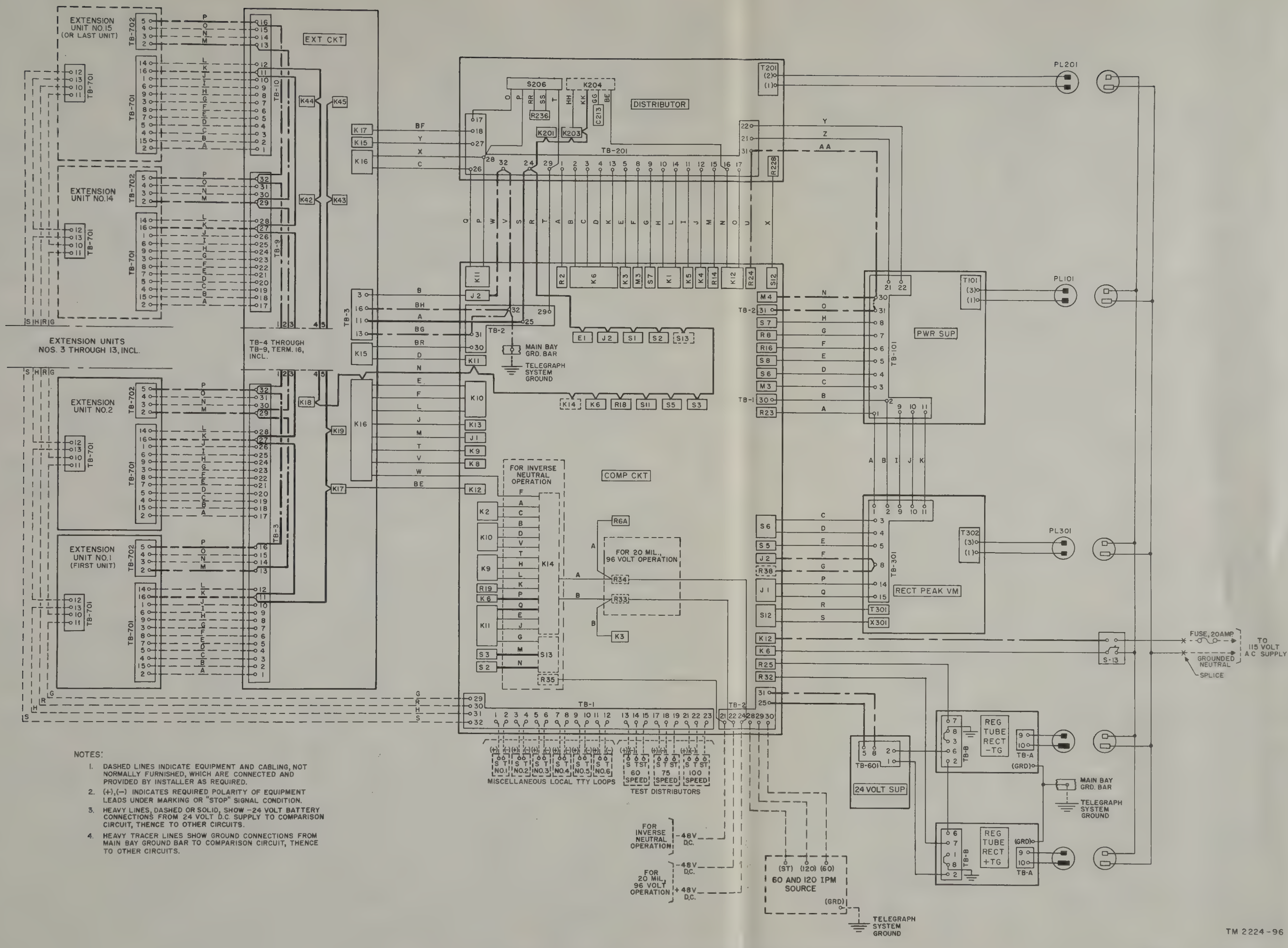


Figure 66. Ac supply circuit, wiring diagram.

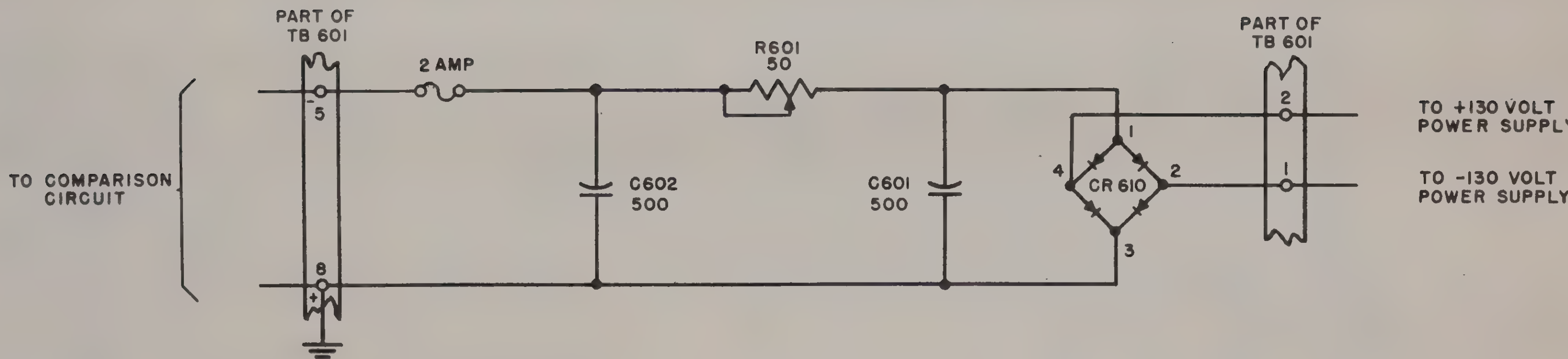


NOTES:

1. DASHED LINES INDICATE EQUIPMENT AND CABLING, NOT NORMALLY FURNISHED, WHICH ARE CONNECTED AND PROVIDED BY INSTALLER AS REQUIRED.
2. (+),(−) INDICATES REQUIRED POLARITY OF EQUIPMENT LEADS UNDER MARKING OR "STOP" SIGNAL CONDITION.
3. HEAVY LINES, DASHED OR SOLID, SHOW −24 VOLT BATTERY CONNECTIONS FROM 24 VOLT D.C. SUPPLY TO COMPARISON CIRCUIT, THENCE TO OTHER CIRCUITS.
4. HEAVY TRACER LINES SHOW GROUND CONNECTIONS FROM MAIN BAY GROUND BAR TO COMPARISON CIRCUIT, THENCE TO OTHER CIRCUITS.

TM 2224-96

Figure 67. Teletypewriter Test Set TS–611A/FG, interconnection diagram.



NOTES:

1. RESISTORS ARE IN OHMS; CAPACITORS ARE IN UF.
2. FOR CONNECTIONS TO OTHER CIRCUITS, SEE OVERALL SCHEMATIC AND INTERCONNECTION DIAGRAMS.

TM 2224-53

Figure 68. Power supply circuit, 24-volt dc schematic diagram.

CHAPTER 7
SHIPMENT AND LIMITED STORAGE AND DEMOLITION TO PREVENT ENEMY USE

Section I. SHIPMENT AND LIMITED STORAGE

127. Disassembly

The following instructions are recommended as a guide for preparing the teletypewriter test set for shipment and limited storage.

a. Remove all outside leads such as ground wires, extension unit cables, auxiliary equipment wires, and power cords (pars. 18–25).

b. Inspect the equipment for damage.

(1) Secure loose parts.

(2) Replace broken or damaged parts.

(3) Repair if necessary.

c. Inspect the equipment for completeness (par. 16).

(1) Fuses.

(2) Tubes.

(3) Relays.

128. Repacking for Shipment or Limited Storage

a. When the teletypewriter test set is to be repacked for shipment or limited storage and is disassembled as indicated in paragraph 127, pack components in original packing cases. If the original packing cases are not available, packing cases of suitable size and construction may be used (*b* below). It is important to block the unit in the packing cases so that the equipment protruding from the front of the teletypewriter test set is not damaged during moving or shipment. Blocking also will prevent movement of the equipment and reduce the chances of damage during transit. If the building or warehouse where the equipment is to be stored is in a damp area, insert bags of desiccant to protect the equipment from the effects of moisture. Protect the packing cases with a sealed waterproof paper barrier during storage. If the equipment is to be shipped, wrap the equipment inside of the packing case with a waterproof paper barrier. Seal the seams of the paper barrier with waterproofing compound or tape. On the packing cases, indicate the date on which the equipment was removed from service and whether it was functioning properly at the time of its removal. If it was functioning improperly, indicate the cause of faulty operation and notify authorized maintenance personnel of this fact.

b. The exact procedure in repacking for shipment or limited storage depends on the material available. Use figure 4 as an aid.

Section II. DEMOLITION OF MATERIEL TO PREVENT ENEMY USE

129. Authority for Demolition

The demolition procedure (par. 130) will be used to prevent the enemy from using or salvaging this equipment. Demolition of the equipment will be accomplished only upon order of the commander.

130. Methods of Destruction

a. Smash. Smash the controls, tubes, coils, switches, capacitors, and transformers; use sledges, axes, pickaxes, hammers, crowbars or other heavy tools.

b. Cut. Cut all cords, cables, and wiring; use axes, handaxes, or machetes.

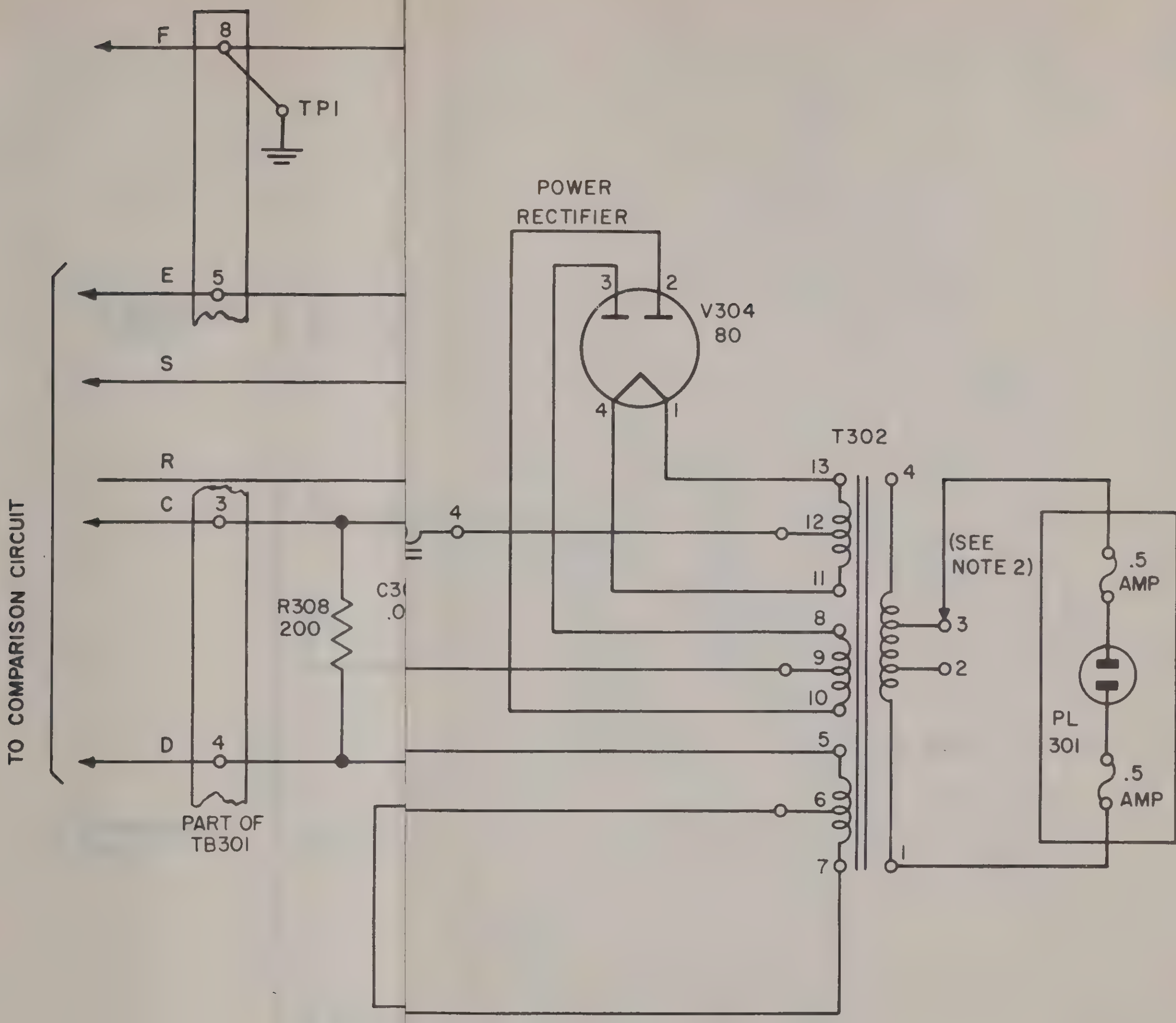
c. Burn. Burn cables, resistors, capacitors, coils, wiring, and technical manuals; use gasoline, kerosene, oil, flame throwers, or incendiary grenades.

d. Bend. Bend panels, transit cases, and chassis.

e. Explosives. If explosives are necessary, use firearms, grenades, or TNT.

f. Disposal. Bury or scatter the destroyed parts in slit trenches, foxholes, or other holes, or throw them into streams.

g. Destroy. Destroy everything.



NLESS OTHERWISE INDICATED, RESISTORS AND INDUCTORS
RE IN OHMS, CAPACITORS ARE IN UF.

ONNECTIONS TO TAPS 2, 3, AND 4 ON TRANSFORMER T302 MAY
E CHANGED TO COMPENSATE FOR INPUT VOLTAGE VARIATIONS.

OR CONNECTIONS TO OTHER CIRCUITS, SEE OVERALL
CHEMATIC AND INTERCONNECTION DIAGRAMS.

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CHAPTER 7

SHIPMENT AND LIMITED STORAGE AND DEMOLITION TO PREVENT ENEMY USE

Section I. SHIPMENT AND LIMITED STORAGE

127. Disassembly

The following instructions are recommended as a guide for preparing the teletypewriter test set for shipment and limited storage.

a. Remove all outside leads such as ground wires, extension unit cables, auxiliary equipment wires, and power cords (pars. 18–25).

b. Inspect the equipment for damage.

(1) Secure loose parts.

(2) Replace broken or damaged parts.

(3) Repair if necessary.

c. Inspect the equipment for completeness (par. 16).

(1) Fuses.

(2) Tubes.

(3) Relays.

128. Repacking for Shipment or Limited Storage

a. When the teletypewriter test set is to be repacked for shipment or limited storage and is disassembled as indicated in paragraph 127, pack components in original packing cases. If the original packing cases are not available, packing cases of suitable size and construction may be used (*b* below). It is important to block the unit in the packing cases so that the equipment protruding from the front of the teletypewriter test set is not damaged during moving or shipment. Blocking also will prevent movement of the equipment and reduce the chances of damage during transit. If the building or warehouse where the equipment is to be stored is in a damp area, insert bags of desiccant to protect the equipment from the effects of moisture. Protect the packing cases with a sealed waterproof paper barrier during storage. If the equipment is to be shipped, wrap the equipment inside of the packing case with a waterproof paper barrier. Seal the seams of the paper barrier with waterproofing compound or tape. On the packing cases, indicate the date on which the equipment was removed from service and whether it was functioning properly at the time of its removal. If it was functioning improperly, indicate the cause of faulty operation and notify authorized maintenance personnel of this fact.

b. The exact procedure in repacking for shipment or limited storage depends on the material available. Use figure 4 as an aid.

Section II. DEMOLITION OF MATERIEL TO PREVENT ENEMY USE

129. Authority for Demolition

The demolition procedure (par. 130) will be used to prevent the enemy from using or salvaging this equipment. Demolition of the equipment will be accomplished only upon order of the commander.

130. Methods of Destruction

a. Smash. Smash the controls, tubes, coils, switches, capacitors, and transformers; use sledges, axes, pickaxes, hammers, crowbars or other heavy tools.

b. Cut. Cut all cords, cables, and wiring; use axes, handaxes, or machetes.

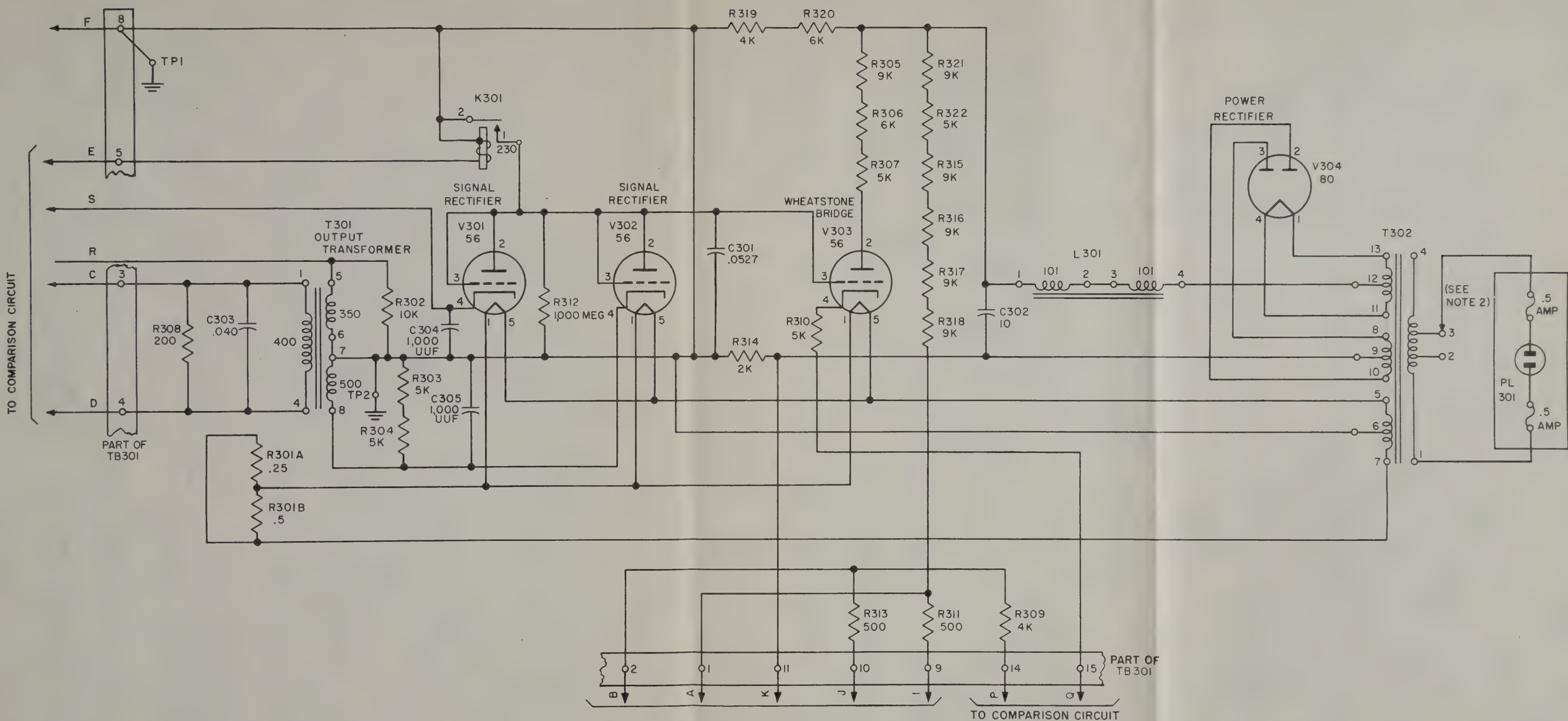
c. Burn. Burn cables, resistors, capacitors, coils, wiring, and technical manuals; use gasoline, kerosene, oil, flame throwers, or incendiary grenades.

d. Bend. Bend panels, transit cases, and chassis.

e. Explosives. If explosives are necessary, use firearms, grenades, or TNT.

f. Disposal. Bury or scatter the destroyed parts in slit trenches, foxholes, or other holes, or throw them into streams.

g. Destroy. Destroy everything.



NOTES:

1. UNLESS OTHERWISE INDICATED, RESISTORS AND INDUCTORS ARE IN OHMS, CAPACITORS ARE IN UF.

2. CONNECTIONS TO TAPS 2, 3, AND 4 ON TRANSFORMER T302 MAY BE CHANGED TO COMPENSATE FOR INPUT VOLTAGE VARIATIONS.

3. FOR CONNECTIONS TO OTHER CIRCUITS, SEE OVERALL SCHEMATIC AND INTERCONNECTION DIAGRAMS.

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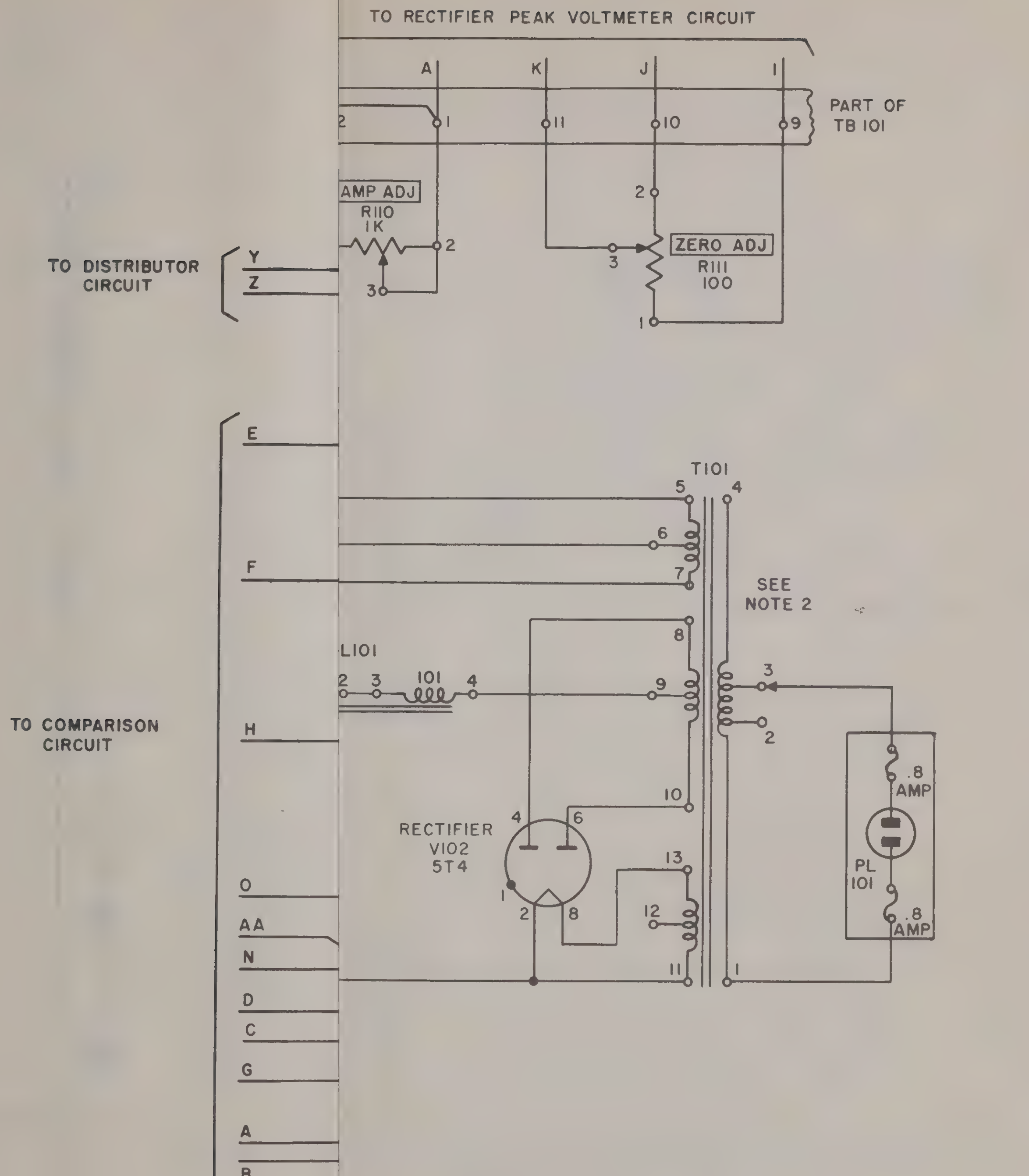
Figure 69. Rectifying peak voltmeter circuit, schematic diagram.



NOTES:

1. ALL RESISTORS AND INDUCTORS ARE IN OHMS; CAPACITORS ARE IN UF.
2. CONNECTION TO TAPS 2, 3, AND 4 ON TRANSFORMER T101 MAY BE CHANGED TO COMPENSATE FOR ANY CHANGE IN INPUT LINE VOLTAGE.
3. FOR CONNECTION TO OTHER CIRCUITS, SEE OVERALL SCHEMATIC AND INTERCONNECTION DIAGRAMS.

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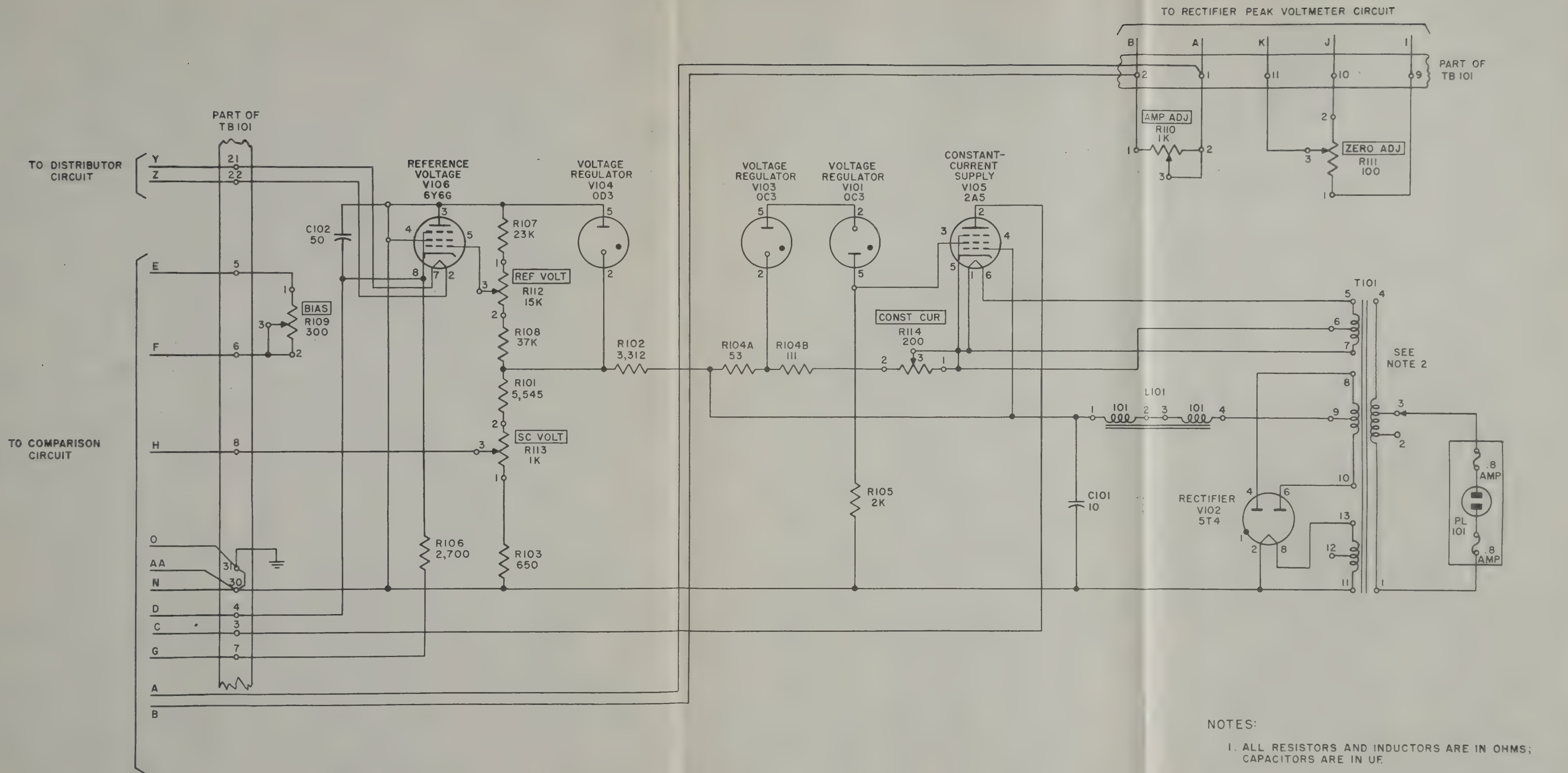

NOTES:

1. ALL RESISTORS AND INDUCTORS ARE IN OHMS; CAPACITORS ARE IN UF.
2. CONNECTION TO TAPS 2, 3, AND 4 ON TRANSFORMER T101 MAY BE CHANGED TO COMPENSATE FOR ANY CHANGE IN INPUT LINE VOLTAGE.
3. FOR CONNECTION TO OTHER CIRCUITS, SEE OVERALL SCHEMATIC AND INTERCONNECTION DIAGRAMS.

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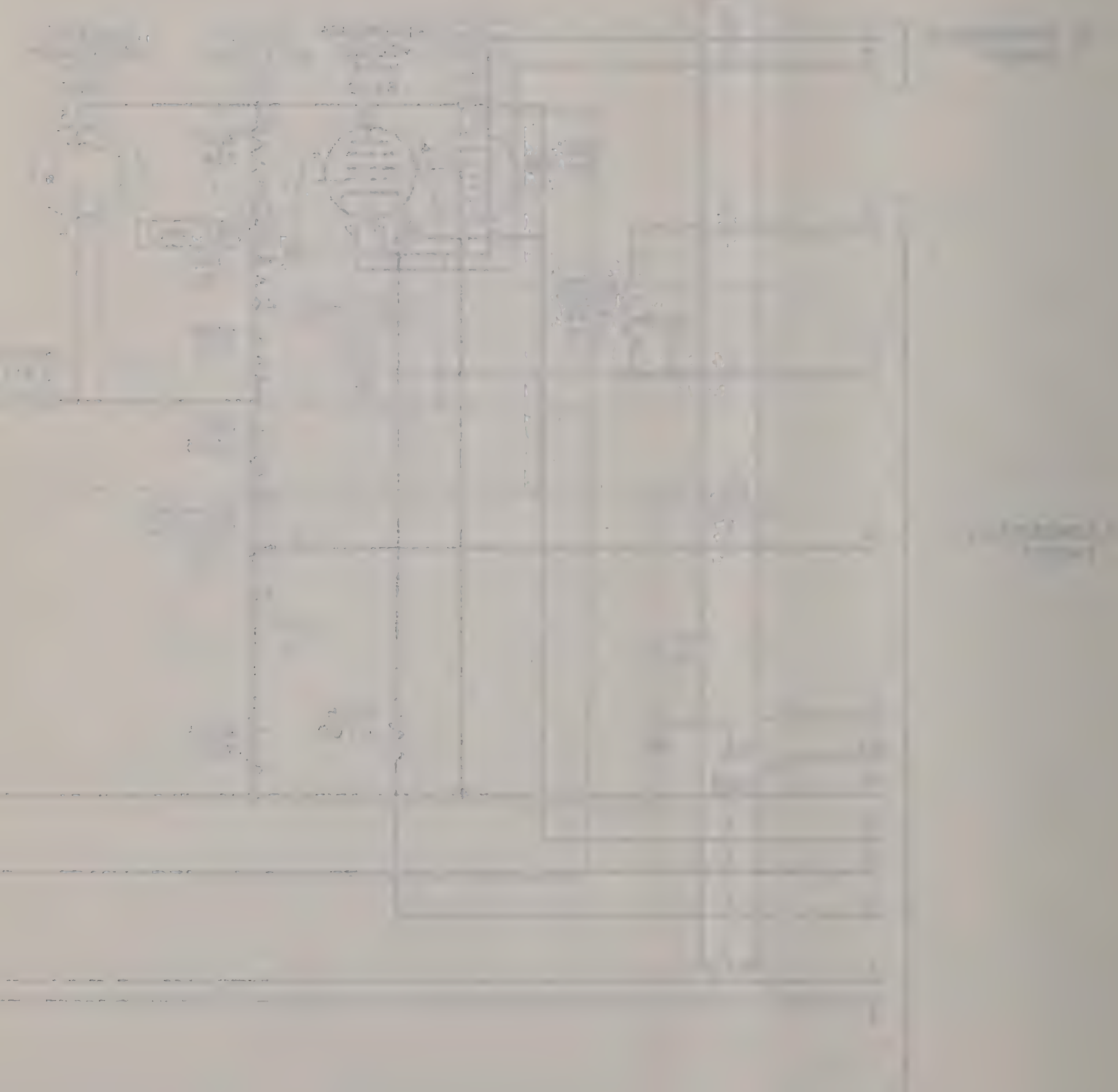
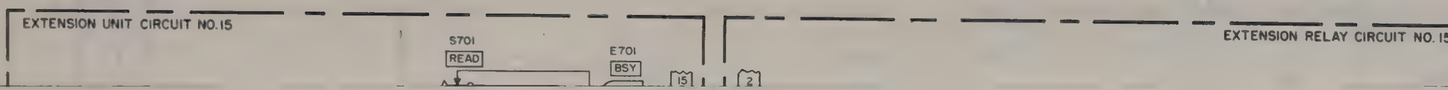
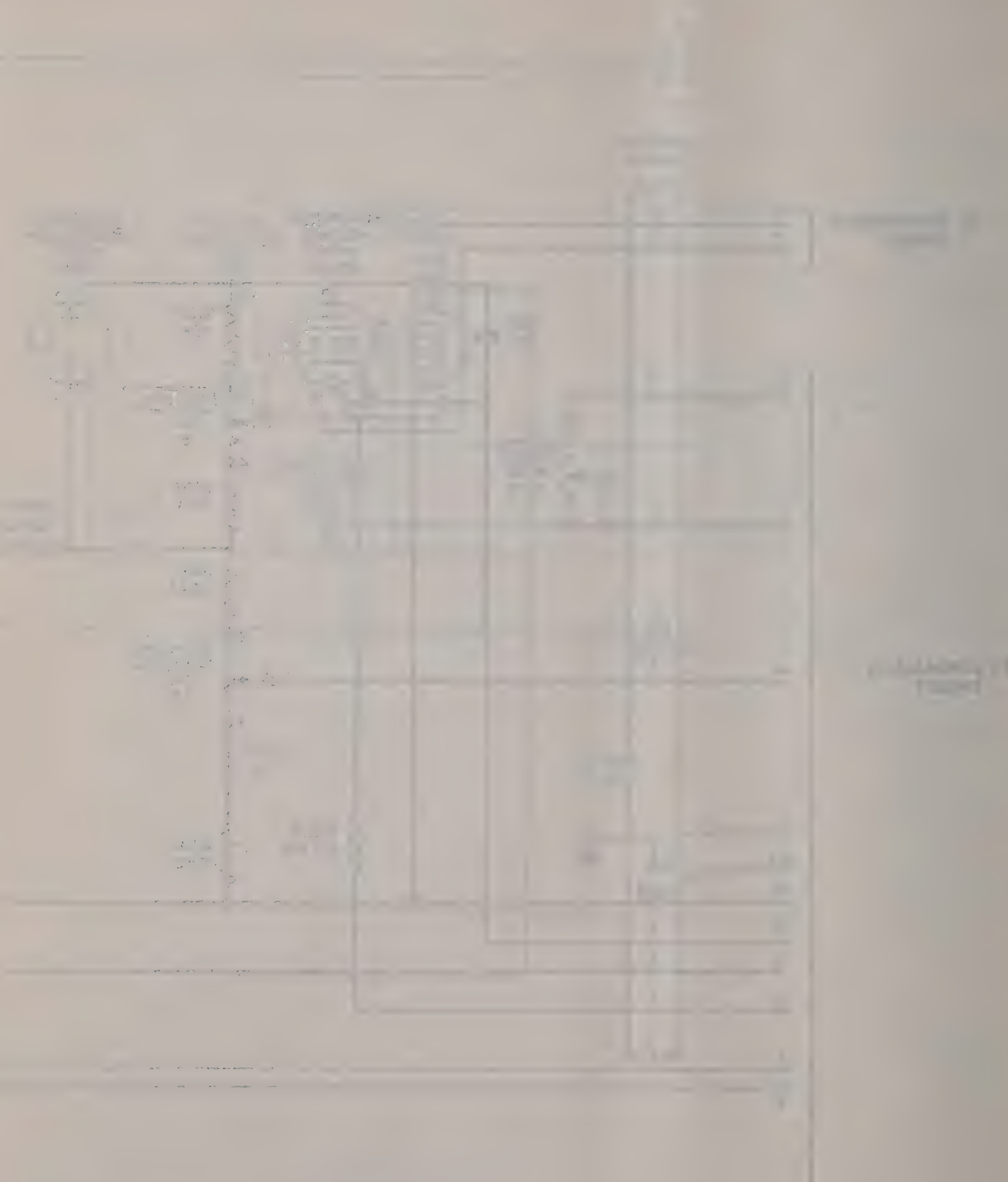
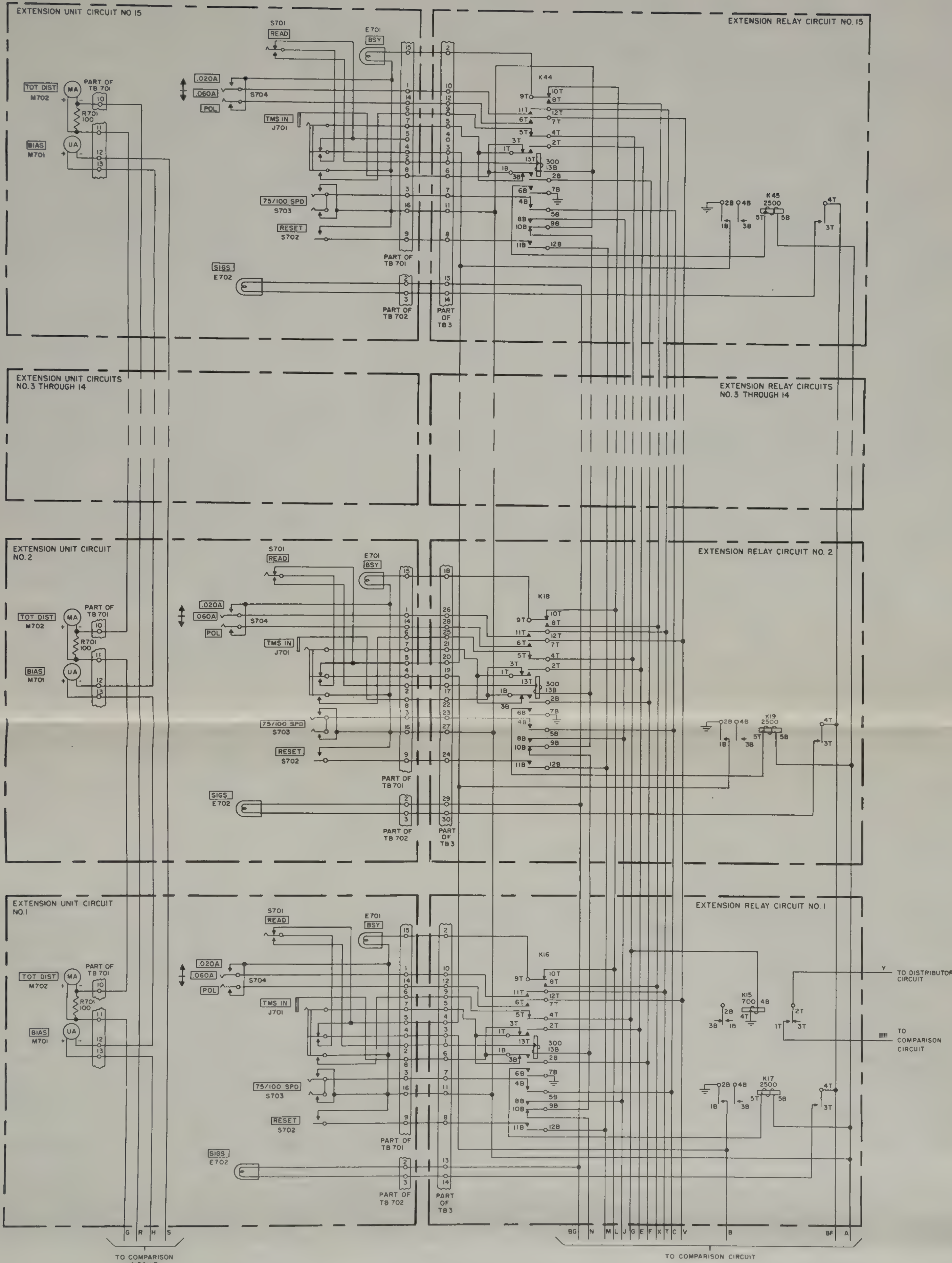
Figure 70. Power supply circuit, schematic diagram.




EXTENSION UNIT CIRCUIT NO.15
S701
READ
E701
BSY
15
2
EXTENSION RELAY CIRCUIT NO. 15

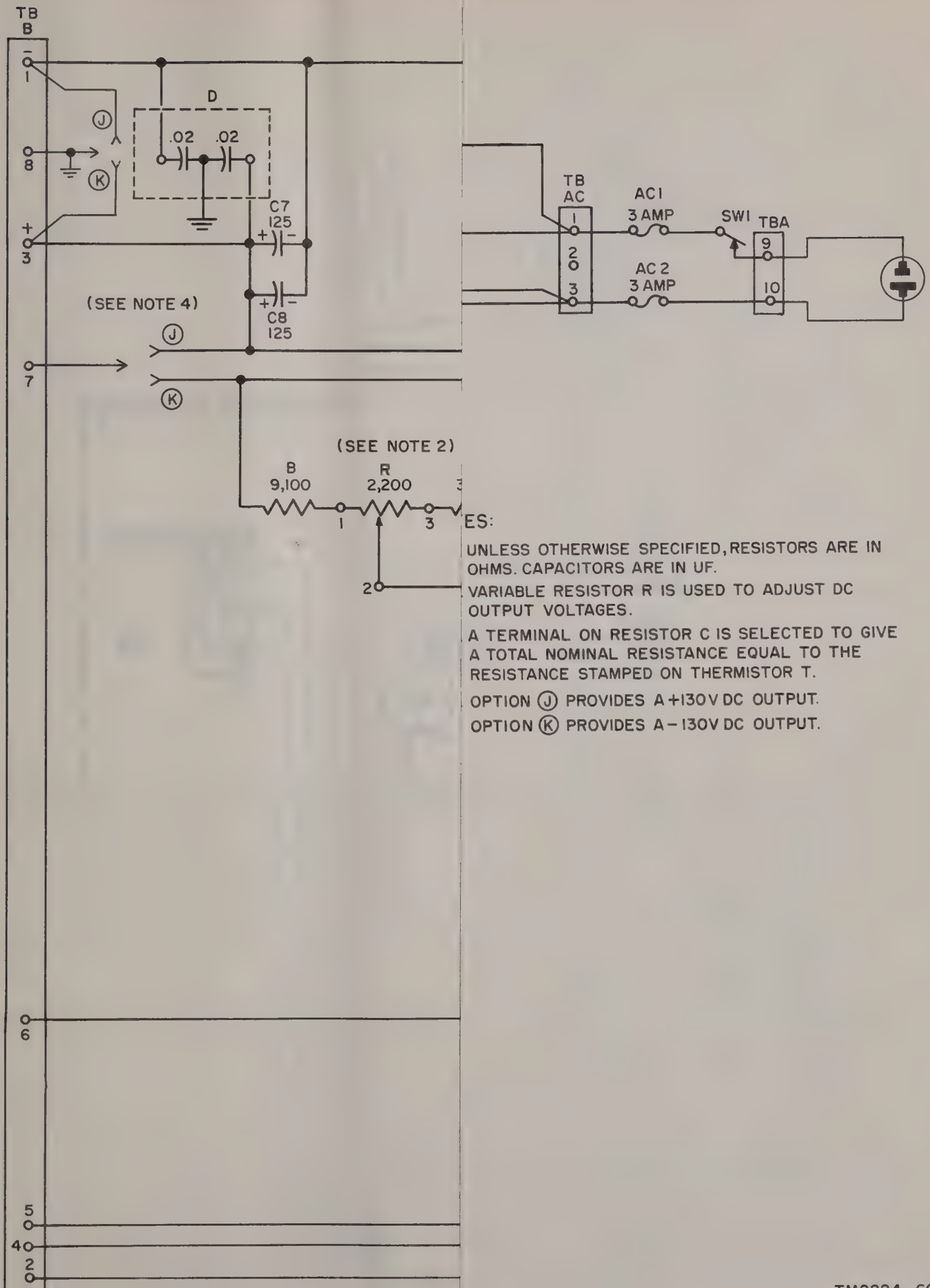




NOTES
1 RESISTANCES ARE IN OHMS
2 FOR CONNECTIONS TO OTHER CIRCUITS, SEE OVERALL SCHEMATIC AND INTERCONNECTION DIAGRAMS

TM2224-64

Figure 71. Extension unit circuit, schematic diagram.



ES:

UNLESS OTHERWISE SPECIFIED, RESISTORS ARE IN OHMS. CAPACITORS ARE IN UF.

VARIABLE RESISTOR R IS USED TO ADJUST DC OUTPUT VOLTAGES.

A TERMINAL ON RESISTOR C IS SELECTED TO GIVE A TOTAL NOMINAL RESISTANCE EQUAL TO THE RESISTANCE STAMPED ON THERMISTOR T.

OPTION (J) PROVIDES A +130V DC OUTPUT.

OPTION (K) PROVIDES A −130V DC OUTPUT.

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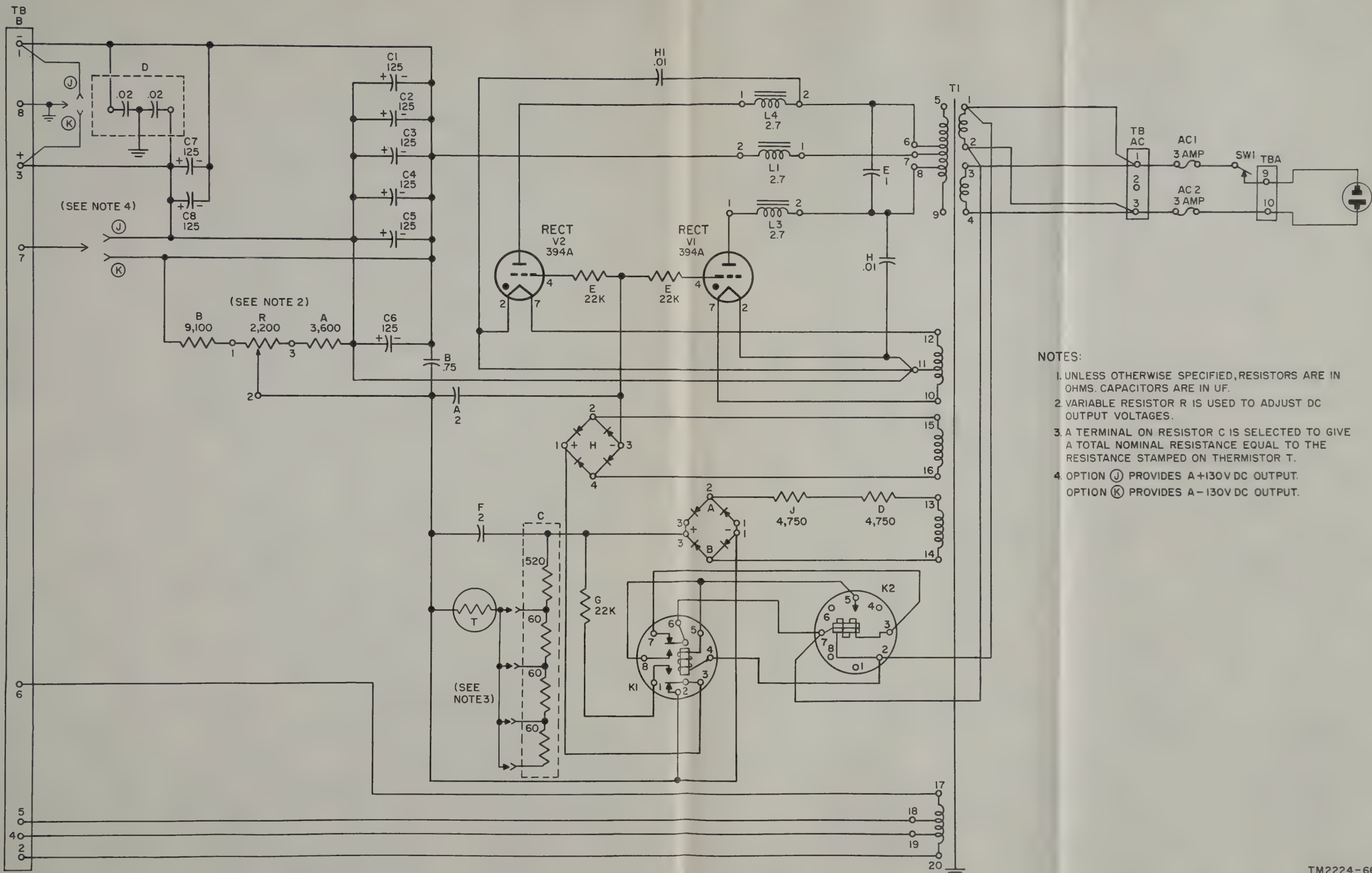

NOTES:

1. UNLESS OTHERWISE SPECIFIED, RESISTORS ARE IN OHMS. CAPACITORS ARE IN UF.
2. VARIABLE RESISTOR R IS USED TO ADJUST DC OUTPUT VOLTAGES.
3. A TERMINAL ON RESISTOR C IS SELECTED TO GIVE A TOTAL NOMINAL RESISTANCE EQUAL TO THE RESISTANCE STAMPED ON THERMISTOR T.
4. OPTION (J) PROVIDES A +130V DC OUTPUT. OPTION (K) PROVIDES A −130V DC OUTPUT.

TM2224-66

Figure 72. Regulated tube rectifier circuit, schematic diagram.

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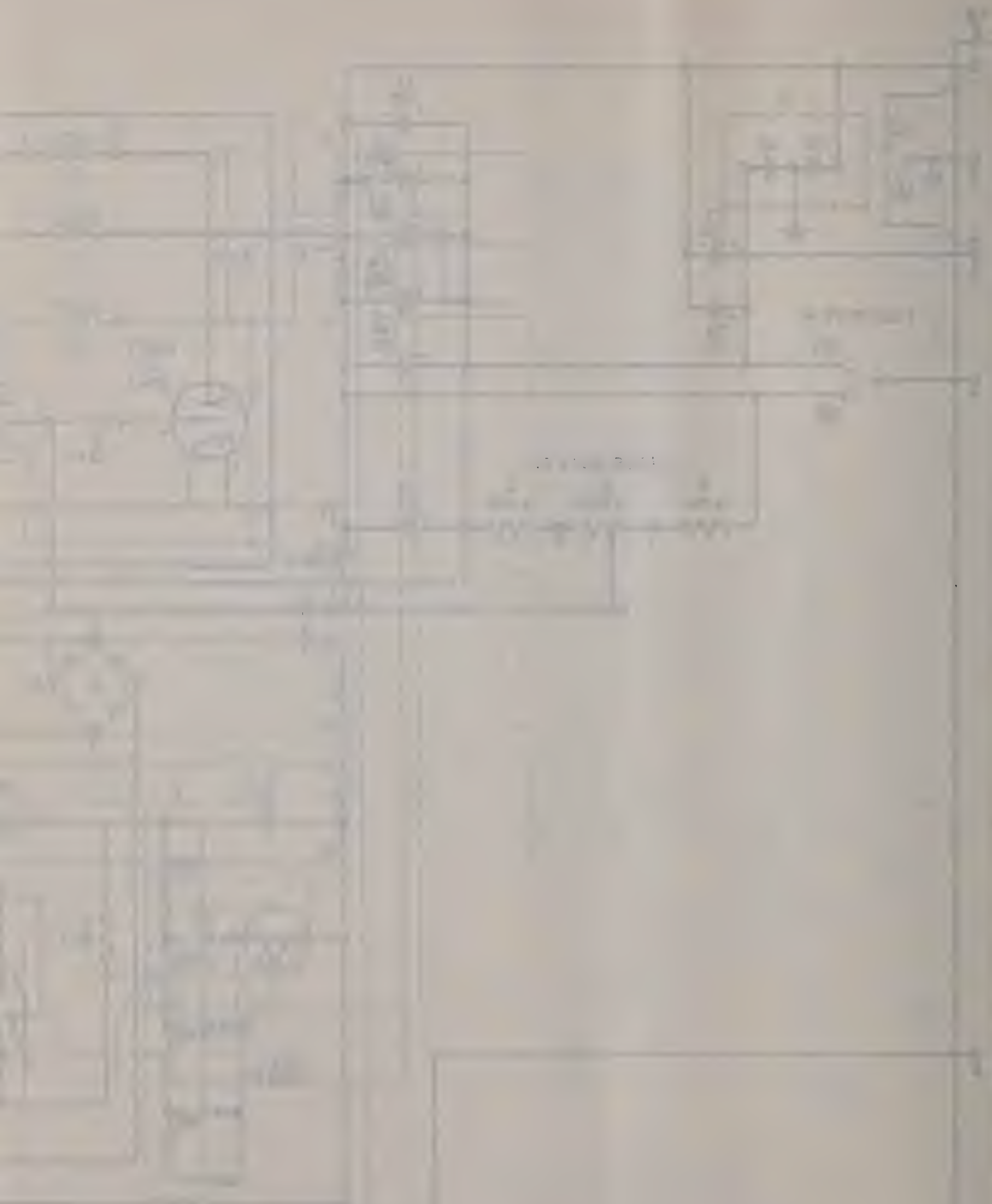
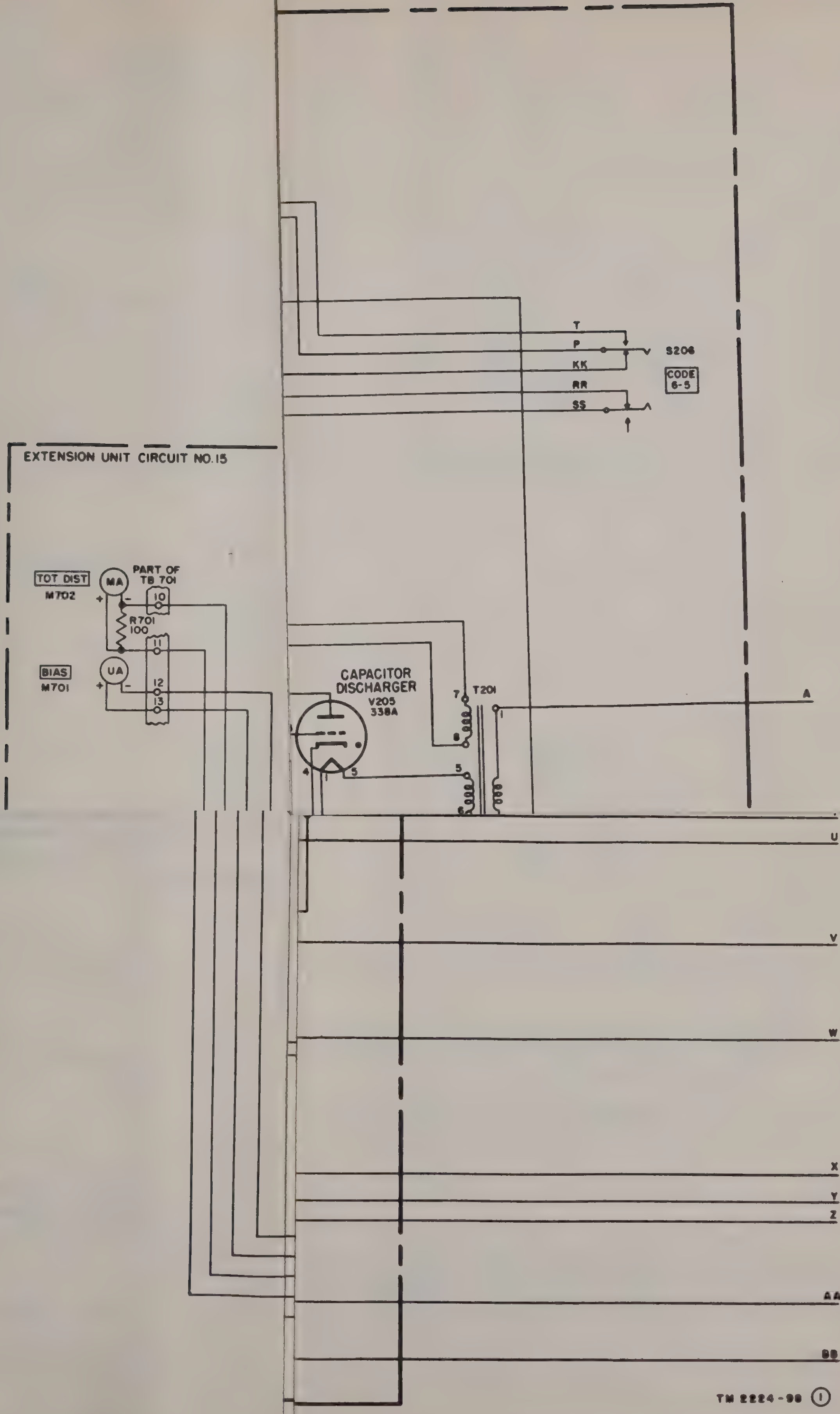
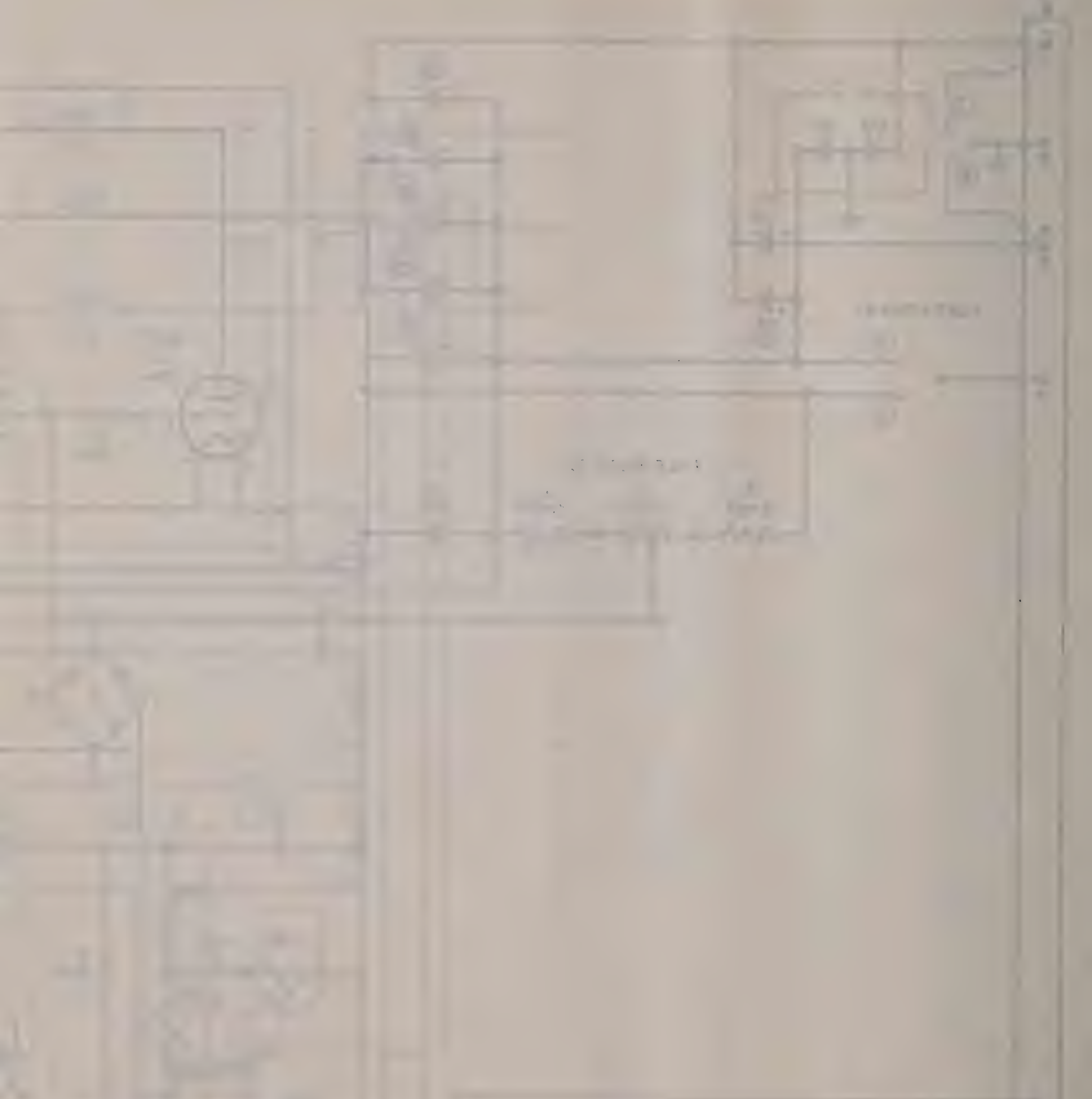



T
P
KK
RR
SS
S206
CODE 6-5
EXTENSION UNIT CIRCUIT NO.15
TOT DIST
M702
MA
PART OF TB 701
10
R701 100
11
BIAS
M701
UA
12
13
CAPACITOR DISCHARGER
V205 338A
T201
A
U
V
W
X
Y
Z
AA
BB
TM 2224-90 1



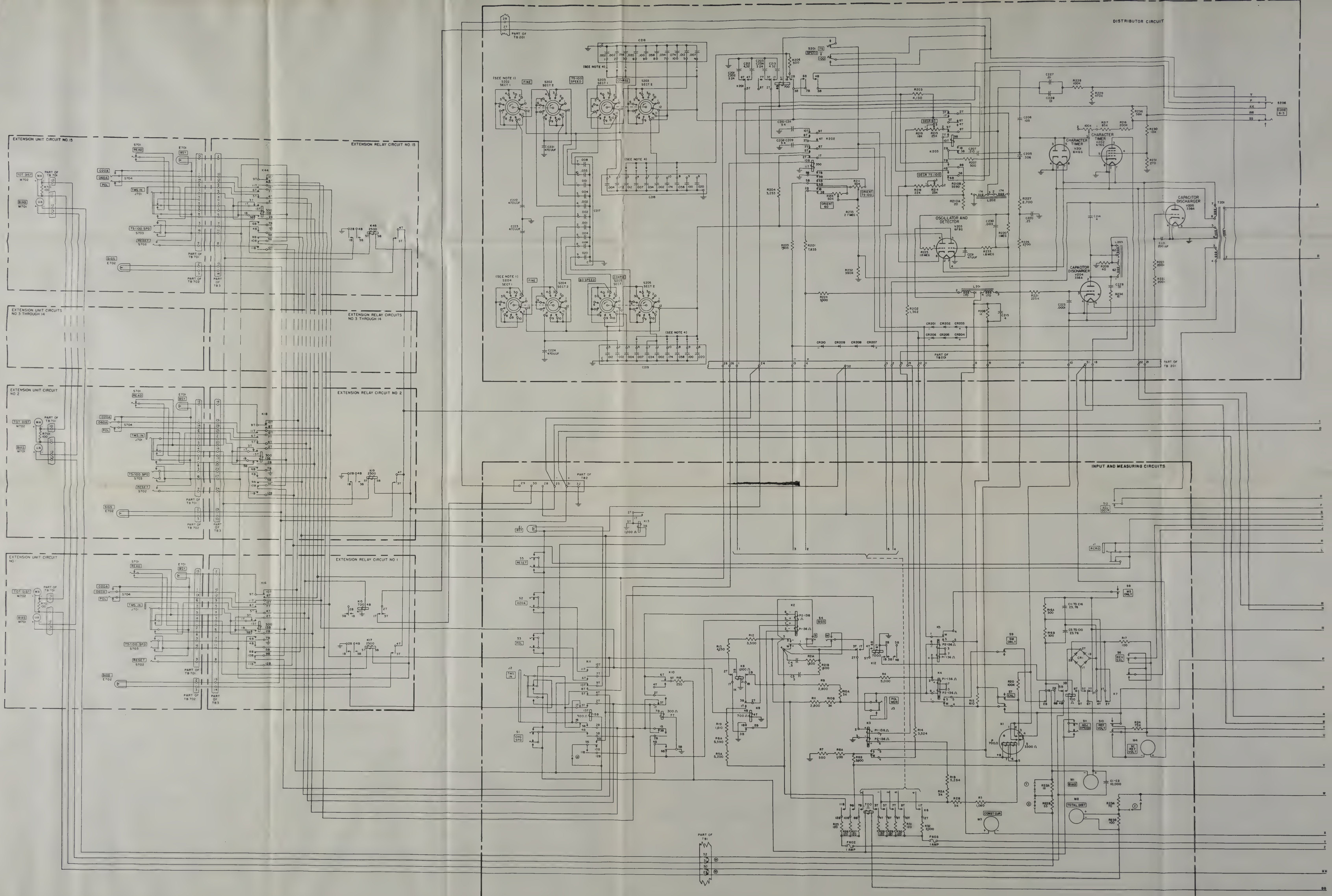
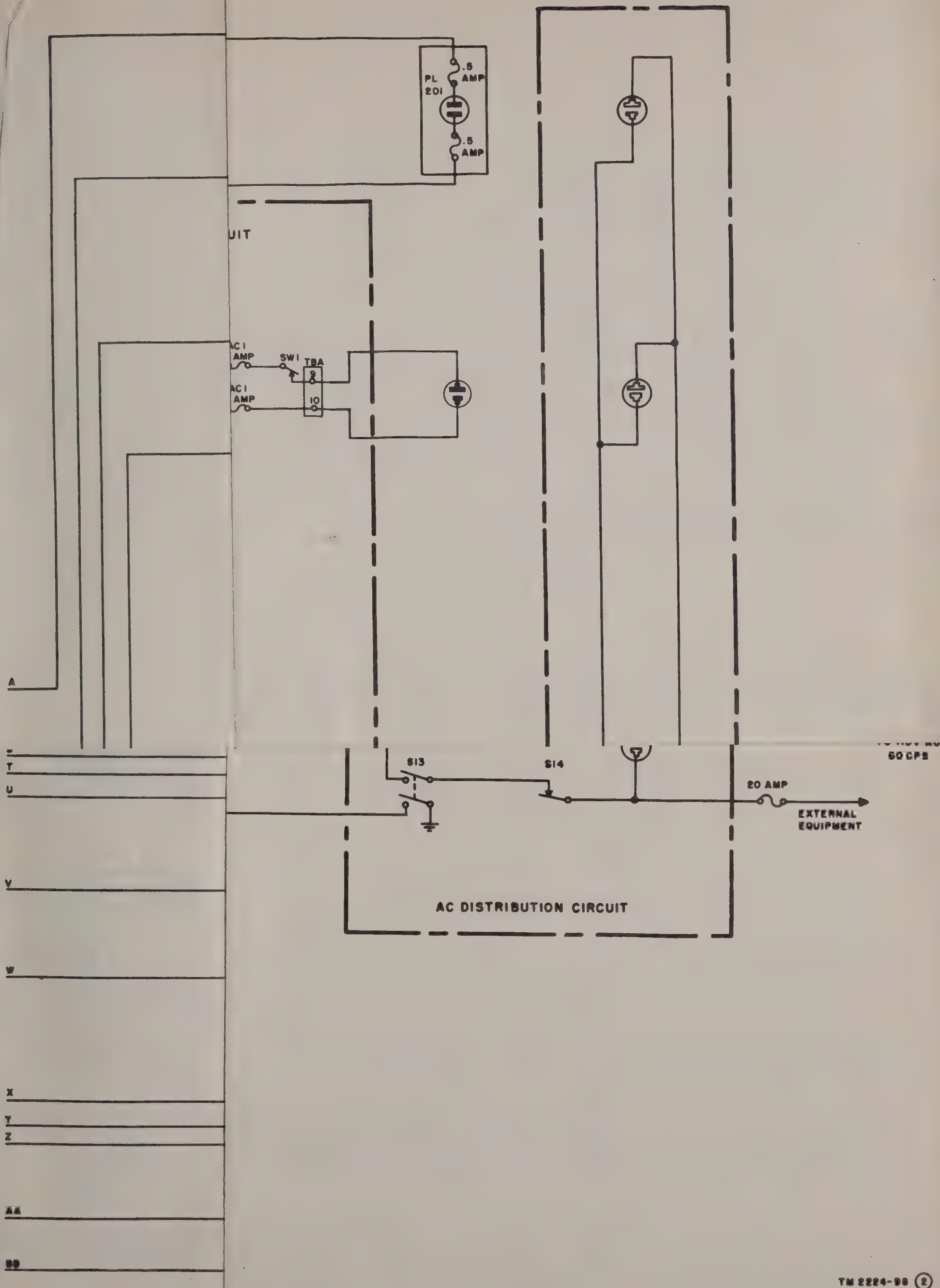


Figure 73. Teletypewriter Test Set TS-611A/FG, overall schematic diagram.



.5 AMP
PL 201
.5 AMP
UIT
AC 1 AMP
SW1
TBA
9
AC 1 AMP
10
A
T
U
S13
S14
50 CPS
20 AMP
EXTERNAL EQUIPMENT
AC DISTRIBUTION CIRCUIT
V
W
X
Z
AA
BB
TM 2224-98 (2)

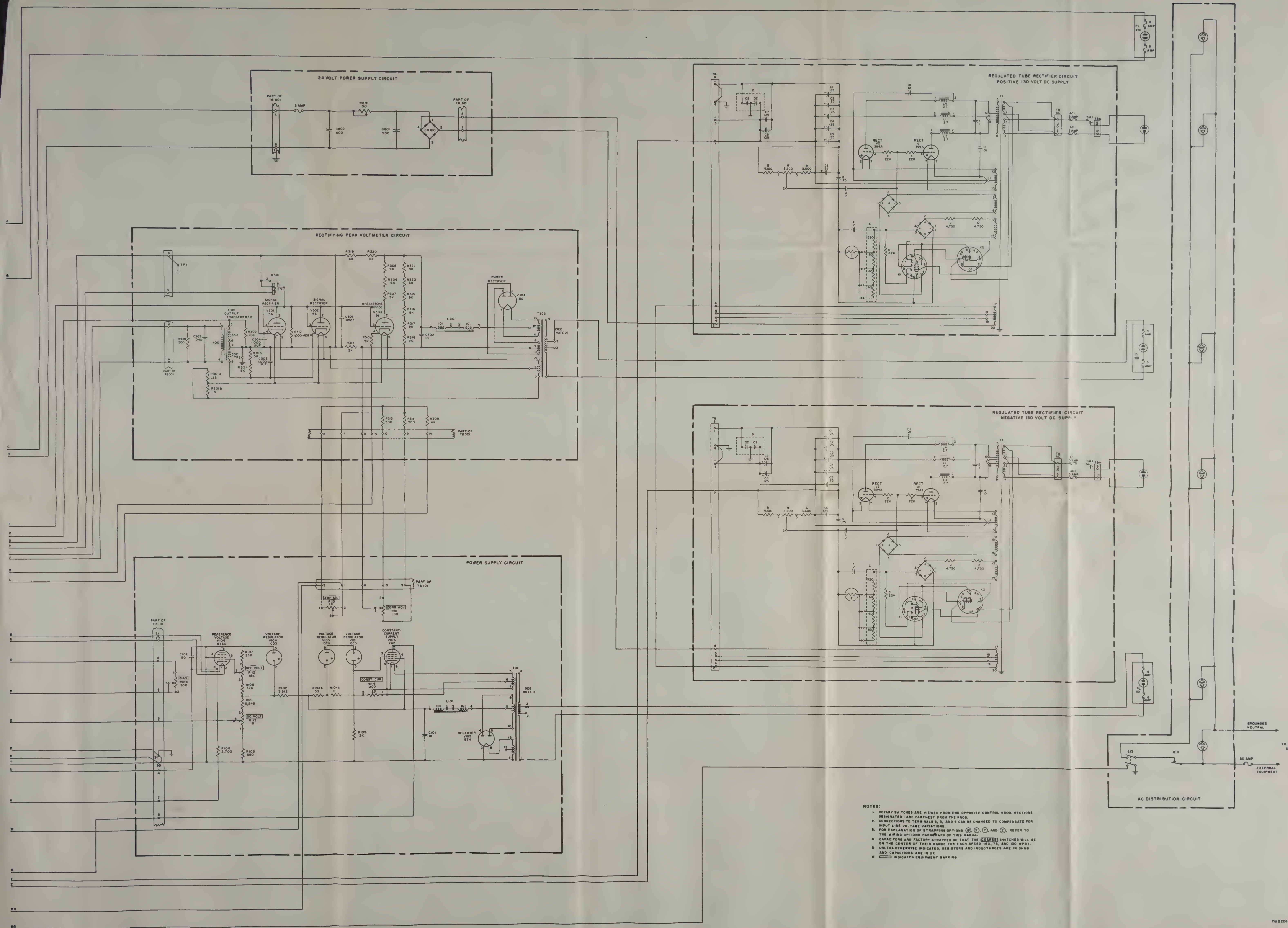
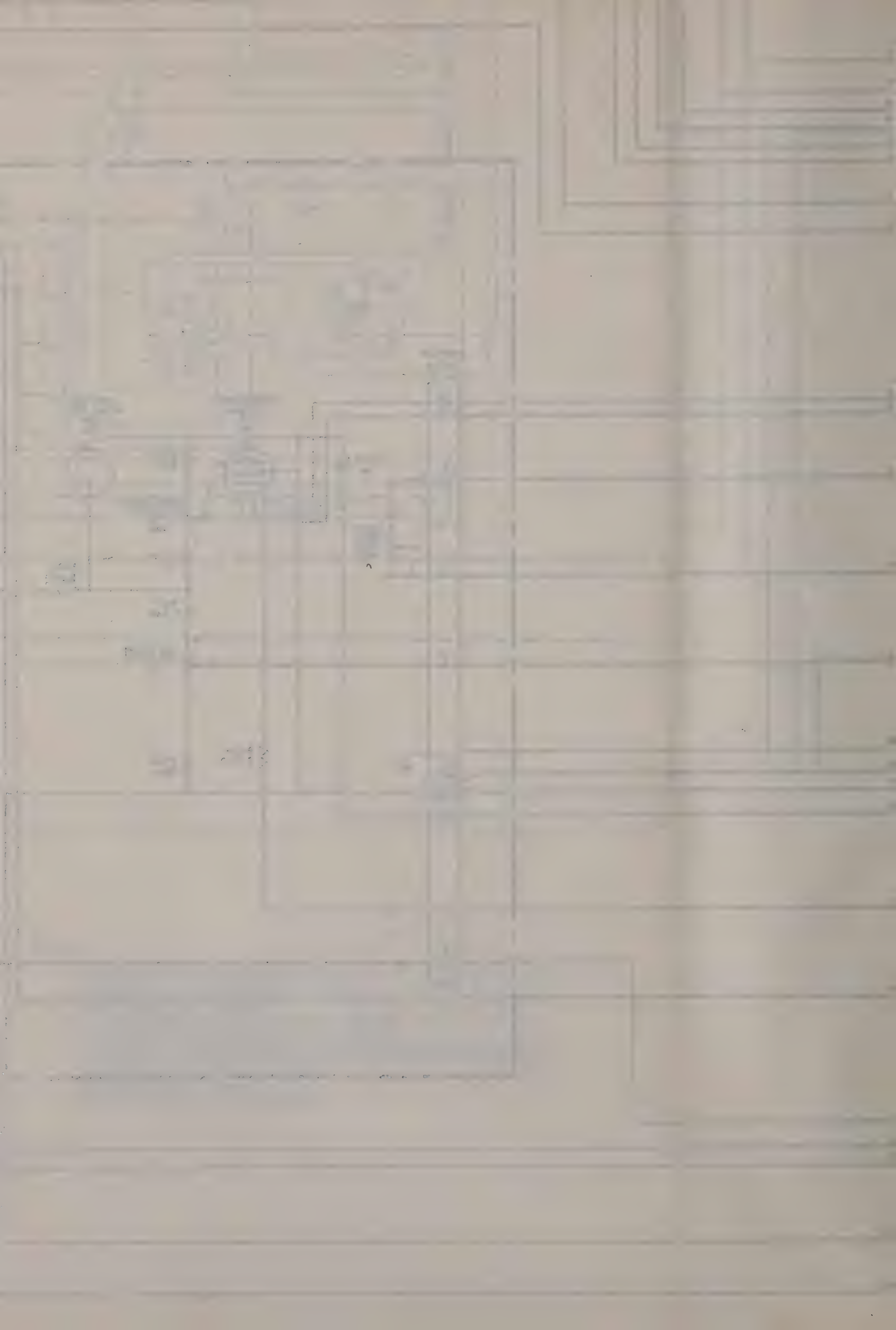


Figure 73. Continued.



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[AG 413.48 (31 Oct. 55)]

By Order of *Wilbur M. Brucker*, Secretary of the Army:

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Chief of Staff.

Official:
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NG: State AG (6); Units—same as Active Army except allowance is one copy to each unit.
USAR: None.
For explanation of abbreviations used, see SR 320–50–1.

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